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Environmental Impact Guidelines for New Source Canned and Preserved Seafood Processing Facilities

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16. ABSTRACT

This guideline document has been prepared to augment the information previously released by the Office of Federal Activities entitled Environmental Impact Assessment Guidelines for Selected New Source Industries. Its purpose is to provide guidance for the preparation and/or review of environmental documents (Environmental Information Document or Environmental Impact Statement) which EPA may require under the authority of the National Environmental Policy Act (NEPA) as part of the new source (NPDES) permit application review process.

This document has been prepared in six sections, organized in a manner to facilitate analysis of the various facets of the environmental review process. The initial section includes a broad overview of the industry intended to familiarize the audience with the processes, trends, impacts and applicable pollution regulations commonly encountered in the canned and preserved seafood processing industry. Succeeding sections provide a comprehensive identification and analysis of potential environmental impacts, pollution control technologies available to meet Federal standards, and evaluation of available alternatives. The document concludes with two sections: a comprehensive listing of references for further reading, and a glossary of terms common to the industry.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Office of Federal Activities
Washington, D.C. 20460

1-a

Preface

This document is one of a series of industry-specific Environmental Impact Guidelines being developed by the Office of Federal Activities (OFA) for use in EPA's Environmental Impact Statement preparation program for new source NPDES permits. It is to be used in conjunction with Environmental Impact Assessment Guidelines for Selected New Source Industries, an OFA publication that includes a description of impacts common to most industrial sources.

The requirement for Federal agencies to assess the environmental impacts of their proposed actions is included in Section 102 of the National Environmental Policy Act of 1969 (NEPA), as amended. The stipulation that EPA's issuance of a new source NPDES permit as an action subject to NEPA is in Section 511(c)(1) of the Clean Water Act of 1977. EPA's regulations for preparation of Environmental Impact Statements are in Part 6 of Title 40 of the Code of Federal Regulations; new source requirements are in Subpart F of that Part.

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INTRODUCTION

The Clean Water Act requires that the United States Environmental Protection Agency (USEPA) establish standards of performance for categories of new source industrial wastewater dischargers. Before the discharge of any pollutant to the navigable waters of the United States from a new source in an industrial category for which performance standards have been proposed, a new source National Pollutant Discharge Elimination System (NPDES) permit must be obtained from either USEPA or the state (whichever is the administering authority for the state in which the discharge is proposed). The Clean Water Act also requires that the issuance of a permit by USEPA for a new source discharge be subject to the National Environmental Policy Act (NEPA), which may require preparation of an Environmental Impact Statement (EIS) on the new source. The procedure established by USEPA regulations (40 CFR 6 Subpart F) for applying NEPA to the issuance of new source NPDES permits may require preparation of an Environmental Information Document (EID) by the permit applicant. Each EID is submitted to USEPA and reviewed to determine if there are potentially significant effects on the quality of the human environment resulting from construction and operation of the new source. If there are, USEPA publishes an EIS on the action of issuing the permit.

The purpose of these guidelines is to provide industry-specific guidance to USEPA personnel responsible for determining the scope and content of EIS's and for reviewing them after submission to USEPA. It is to serve as supplementary information to USEPA's previously published document, Environmental Impact Assessment Guidelines for Selected New Source Industries, which includes the general format for an EID and those impact assessment considerations common to all or most industries. Both that document and these guidelines should be used for development of an EID for a new source canned and preserved seafoods processing facility.

These guidelines provide the reader with an indication of the nature of the potential impacts on the environment and the surrounding region from construction and operation of canned and preserved seafoods processing facilities. In this capacity, the volume is intended to assist USEPA personnel in the identification of these impact areas that should be addressed in an EID. In addition, the guidelines present (in Chapter 1.0) a description of the industry; its principal processes; significant environmental problems; and recent trends in location, raw materials processes, pollution control, and environmental impacts. This "Overview of the Industry" is included to familiarize USEPA staff with existing conditions in the industry.

Although this document may be transmitted to an applicant for informational purposes, it should not be construed as representing the procedural requirements for obtaining an NPDES permit or as representing the applicant's total responsibilities relating to the new source EIS program. In addition, the content of an EID for a specific new source application is determined by USEPA in accordance with Section 6.604(b) of Title 40 of the Code of Federal Regulations and this document does not supersede any directive received by the applicant from USEPA's official responsible for implementing that regulation.

The Guideline is divided into five chapters. Chapter 1.0 is the "Overview of the Industry," described above. Chapter 2.0, "Impact Identification," discusses process-related wastes and the impacts that may occur during construction and operation of the facility. Chapter 3.0, "Pollution Control Technology," summarizes the technology for controlling environmental impacts. Chapter 4.0, "Evaluation of Alternatives," summarizes possible alternatives to the proposed action and discusses their evaluation. Chapter 5.0 is a list of references which are useful for additional or more detailed information, and Chapter 6.0 is a glossary of industry-related terms.

1.0 OVERVIEW OF THE INDUSTRY

Canned and Preserved Seafoods Processing refers to that industry which converts fresh seafood products into a more stable and therefore more useful product. These Guidelines deal with seafood processing in the United States, an integral part of the food processing industry which dates back to the beginnings of our nation. Because colonial settlements were generally located along coastal rivers and estuaries, seafoods were an important source of protein. Their processing has evolved from early methods of salting and drying to modern canning and freezing. Improved processing technologies have led to a steady increase in the per capita consumption of fish and shellfish in the United States. The figure for 1972 was 5.5 kg (12.2 lbs) per person, totaling 1,130,000 metric tons (MT) (1,250,000 tons). In 1978 consumption was 6.1 kg (13.4 lbs) per person or 1,220,000 MT (1,450,000 tons) (USDOC 1979b). Of this later figure, approximately 47% was imported and 53% domestically produced. The total retail value of the products was 4.6 billion dollars. The passage of the Fisheries Conservation and Management Act of 1976 should further increase domestic production by restricting (or severely limiting) fishing by foreign vessels within a conservation zone extending 200 miles from the US coastline. This legislation should have a significant impact on the planning and construction of new seafood processing facilities, both shore-based and floating, by reducing the competition for the harvest of species in these waters.

1.1 SUBCATEGORIZATION

The 1972 Standard Industrial Classification (SIC) Manual lists four major classification numbers that include the major sections of the seafood processing industry: SIC 2091, Canned and Cured Fish and Seafoods; SIC 2092, Fresh or Frozen Packaged Fish and Seafoods; SIC 2077, Animal and Marine Fats and Oil; and SIC 2048, Prepared Feeds and Feed Ingredients for Animals and Fowls, Not Elsewhere Classified. This last SIC contains industries manufacturing kelp meal and pellets, crushed shell for feed, and ground oyster shells used as feed additives for animals and fowls. Because very little wastewater is generated by these industries, this SIC is addressed only if the processing is a part of the seafood processing plant. The specific designations included in SIC 2091, 2092, and 2077 are included as Table 1.

Table 1. Canned and preserved seafoods SIC code designations.

SIC 2091 Canned and Cured Fish and Seafoods

Description:

Establishments primarily engaged in cooking and canning fish, shrimp, oysters, clams, crabs, and other seafoods, including soups; and those engaged in smoking, salting, drying or otherwise curing fish for the trade.

Included Industries:

Canned fish, crustacea, and mollusks
Caviar, canned and preserved
Clam bouillon, broth, chowder, juice: bottled or canned
Codfish: smoked, salted, dried, and pickled
Crab meat, canned and preserved
Finnan haddie (smoked haddock)
Fish: boneless, cured, dried, pickled, salted, and smoked
Fish, canned
Fish egg bait, canned
Herring: smoked, salted, dried, and pickled
Mackerel: smoked, salted, dried, and pickled
Oysters, canned and preserved
Salmon: smoked, salted, dried, canned, and pickled
Sardines, canned
Seafood products, canned
Shellfish, canned
Shrimp, canned
Soup, seafood: canned
Tuna fish, canned

SIC 2092 Fresh or Frozen Packaged Fish and Seafoods

Description:

Establishments primarily engaged in preparing fresh and raw or cooked frozen packaged fish and other seafood, including soups. This industry also includes establishments primarily engaged in the shucking and packing of fresh oysters in nonsealed containers.

Included Industries:

Crab meat, fresh: packed in nonsealed containers
Crab meat picking
Fish fillets
Fish: fresh, quick frozen, and cold pack (frozen)--packaged
Fish sticks
Frozen prepared fish
Oysters, fresh: shucking and packing in nonsealed containers
Seafoods: fresh, quick frozen, and cold pack (frozen)--packaged
Shellfish, quick frozen and cold pack (frozen)
Shrimp, quick frozen and cold pack (frozen)
Soups, seafood: frozen

Table 1. Canned and preserved seafoods SIC code designations (cont.).

SIC 2077 Animal and Marine Fats and Oils

Description:

Establishments primarily engaged in manufacturing animal oils, including fish oil and other marine animal oils and fish and animal meal; and those rendering inedible grease and tallow from animal fat, bones, and meat scraps.

Included Industries:

Fish liver oils, crude
Fish meal
Fish oil and fish oil meal
Meat meal and tankage
Oil and meal, fish
Oil, neat's-foot
Oils, animal
Oils, fish and marine animal: herring, menhaden, whale (refined), sardine
Rendering plants, grease and tallow
Stearin, animal: inedible

The industry has been subcategorized for the purpose of establishing effluent limitations by considering factors that are significant in determining the untreated wastewater characteristics or the treatability of such wastes. The factors considered for the purpose of subcategorizing the industry include (USEPA 1974a, USEPA 1975b):

- Variability in raw product supply.
- Condition of raw product on delivery to the processing plant.
- Variety of the species being processed.
- Harvesting method.
- Degree of preprocessing.
- Manufacturing processes and subprocesses.
- Form and quality of finished product.
- Location of plant (taking into account factors such as degree of remoteness from urban centers, climatic conditions, terrain, soil types).
- Age of plant.
- Production capacity and normal operating level.
- Nature of operation (intermittent versus continuous).
- Raw water availability.
- Amenability of the waste to treatment.

Each of these factors was considered significant for the characterization of at least a portion of the industry except for the age of the plant. This was found not to be significant because of a preponderance of relatively new facilities and the tendency to use processes in these facilities similar to those in older plants.

Because of differences in species processed and conditions peculiar to geographic locations, the seafoods processing industry was classified according to 33 subcategories in Title 40, Code of Federal Regulations, Chapter 1, Part 408. The basis for these subcategories is included as Table 2 (e.g., type of seafood, processing technique, facility locations, facility size). In reviewing an EID, it is important that the applicant clearly identify the

Table 2. Summary of the general basis for the canned and preserved seafood industry subcategorization (N.S. = not specified).

Subpart	Seafood	Facility Location	Process	Size
A	Catfish	N.S.	Farmed catfish	1,362 kg/day (3,000 lb)
B	Blue crab	N.S.	Conventional	1,362 kg/day (3,000 lb)
C	Blue crab	N.S.	Mechanized	N.S.
D	Dungeness, tanner, and king crabs	Non-remote Alaska	Crab meat	N.S.
E	Dungeness, tanner, and king crabs	Remote Alaska	Crab meat	N.S.
F	Dungeness, tanner, and king crabs	Non-remote Alaska	Whole crab and crab sections	N.S.
G	Dungeness, tanner, and king crabs	Remote Alaska	Whole crab and crab sections	N.S.
H	Dungeness and tanner crabs	Contiguous U.S.	N.S.	N.S.
I	Shrimp	Non-remote Alaska	N.S.	N.S.
J	Shrimp	Remote Alaska	N.S.	N.S.
K	Shrimp	Northern contiguous U.S.(WA, OR, CA, ME, NH, MA)	N.S.	908 kg/day (2,000 lb)
L	Shrimp	Southern contiguous states (NC, SC, GA, FL, AL, MS, LA, TX)	Non-breaded	908 kg/day (2,000 lb)
M	Shrimp	Contiguous U.S.	Breaded	908 kg/day (2,000 lb)
N	Tuna	N.S.	N.S.	N.S.
O	Fish meal (menhaden and anchovy)	Gulf and Atlantic Coast (menhaden); West Coast (anchovy)	N.S.	N.S.
P	Salmon	Alaska	Hand-butchering	N.S.

Table 2. Summary of the general basis for the canned and preserved seafood industry subcategorization (N.S. = not specified) (cont.).

Subpart	Seafood	Facility Location	Process	Size
Q	Salmon	Alaska	Mechanized butchering	N.S.
R	Salmon	West Coast	Hand-butchering	N.S.
S	Salmon	West Coast	Mechanized butchering	N.S.
T	Bottomfish (Halibut)	Alaska	N.S.	N.S.
U	Bottomfish (e.g., flounder, ocean perch, haddock, cod, sea catfish, sole, halibut, rockfish)	Non-Alaskan	Manual methods (predominately)	N.S.
V	Bottomfish (e.g., whiting, croaker)	Non-Alaskan	Mechanized	N.S.
W	Clam	N.S.	Hand-shucked	1,816 kg/day (4,000 lb)
X	Clam	N.S.	Mechanized	N.S.
Y	Oyster	Pacific Coast	Hand-shucked	454 kg/day (1,000 lb)
Z	Oyster	Atlantic and Gulf Coast	Hand-shucked	7,454 kg/day (1,000 lb)
AA	Oyster (steamed and canned)	N.S.	Mechanically (shucked	N.S.
AB	Sardine	N.S.	All except for cutting machines used for preparing fish steaks	N.S.
AC	Scallops	Alaska	N.S.	N.S.
AD	Scallops	Non-Alaskan	N.S.	N.S.
AE	Herring (fillet)	Alaska	N.S.	N.S.

Table 2. Summary of the general basis for the canned and preserved seafood industry subcategorization (N.S. = not specified) (concluded).

Subpart	Seafood	Facility Location	Process	Size
AF	Herring (fillet)	Non-Alaskan	N.S.	N.S.
AG	Abalone	Contiguous U.S.	N.S.	N.S.

Notes

1. Subpart refers to the designation in the Code of Federal Regulations, Title 40 - Protection of the Environment, Chapter 1, Environmental Protection Agency, Subchapter N - Effluent Guidelines and Standards, Part 408 - Canned and Preserved Seafood Processing Point Source Category.

2. Non-remote Alaska refers to population or processing centers including but not limited to Anchorage, Cordova, Juneau, Ketchikan, Kodiak, and Petersburg.

3. Size limitations only apply to existing seafood processors; all new source facilities must comply with applicable effluent limits.

Source: Adapted from 40 CFR 408.

species to be processed and the market (or alternative markets) that is planned for the product. The relationship between the proposed facility and the appropriate industry subcategory must be described clearly because there is a potential for not defining this relationship adequately, in particular for emerging industrial subcategories (e.g., bottomfish or herring). The individual subcategories are described briefly in the following sections (USEPA 1974a, USEPA 1975b, E.C. Jordan 1979).

1.1.1 Farm Raised Catfish Processing

Includes those plants that process farm raised catfish. Wild catfish are not included. The processing techniques of this industry are more homogeneous than most of the other subcategories.

1.1.2 Conventional Blue Crab Processing

Conventional blue crab processing plants generally are concentrated along the Gulf and Atlantic coasts. Most are small operations, utilizing hand-picking methods for the crab meat. Waste streams exhibit similar characteristics and are of low volume. The majority of the liquid wastes come from cooker and clean-up waters.

1.1.3 Mechanized Blue Crab Processing

Mechanized blue crab processing utilizes mechanical pickers to separate the cooked crab meat from the shell. The characteristics and volumes of water are very different from that of a hand-picking plant (e.g., volumes of water may be 30 times that of a hand-picking plant).

1.1.4 Non-remote Alaskan Crab Meat Processing

These plants cook and pick meat from king, dungeness, and tanner crabs, using hand and/or mechanical means. The mechanical pickers use roughly twice as much water as when hand-picking is practiced. A small number of plants produce a large volume of product. The floating or fixed-based plants are located in population or processing centers including, but not limited to, Anchorage, Cordova, Juneau, Ketchikan, Kodiak, and Petersburg.

1.1.5 Remote Alaskan Crab Meat Processing

These plants use the same processes as in 1.1.4 but are located outside the areas listed above. These are identified as a separate subcategory because of the less stringent grind and discharge requirements.

1.1.6 Non-remote Alaskan Whole Crab and Crab Section Processing

These plants process cooked dungeness, whole tanner, and king crabs, or butcher and cook crab sections. The meat is not separated from the shell. The major sources of water are from the cookers and from plant cleaning. These fixed-based or floating plants are located in population or processing centers including, but not limited to, Anchorage, Cordova, Juneau, Ketchikan, Kodiak, and Petersburg.

1.1.7 Remote Alaskan Whole Crab and Crab Section Processing

These plants use the same process as those in Section 1.1.6 but are located outside the population centers listed above. These are identified as a separate subcategory because of the less stringent grind and discharge requirements.

1.1.8 Dungeness and Tanner Crab Processing in the Contiguous States

These plants process dungeness and tanner crab in the contiguous states. This would include whole crabs, sections, or picked meat by any method. Most plants are smaller than the comparable Alaskan plants. Geographic, climate, land, and water differences make this a separate subcategory from the Alaskan crab processors.

1.1.9 Non-remote Alaskan Shrimp Processing

These plants process and can or freeze shrimp in population or processing centers, including but not limited to, Anchorage, Cordova. Juneau, Ketchikan, Kodiak, and Petersburg.

1.1.10 Remote Alaskan Shrimp Processing

These plants process shrimp in areas of Alaska other than those identified previously in Section 1.1.9.

1.1.11 Northern Shrimp Processing in the Contiguous States

These shrimp processing plants cover all processing of shrimp except breading, in Washington, Oregon, California, Maine, New Hampshire, and Massachusetts. The solids, grease and oils, and biochemical oxygen demand (BOD) raw waste loadings are much higher for this subcategory than for the southern non-breaded shrimp industry.

1.1.12 Southern Non-breaded Shrimp Processing in the Contiguous States

These shrimp processing plants cover all processing of shrimp except breading, in the North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas areas.

1.1.13 Breaded Shrimp Processing in the Contiguous States

These plants process breaded shrimp in the 48 contiguous states. The breading operation causes significant increases in BOD and total suspended solids in the raw waste in comparison to shrimp canning and freezing operations.

1.1.14 Tuna Processing

This covers all plants processing tuna either by canning and/or production of by-products. Wastewater characteristics are uniform from region to region, and are not dependent upon plant size.

1.1.15 Fish Meal Processing

This covers all plants processing menhaden on the Gulf and Atlantic coasts and the processing of anchovy on the West Coast into fish meal, oil, and soluble wastes.

1.1.16 Alaskan Hand-butchered Salmon Processing

These Alaskan plants hand-butcher salmon for canning, freezing, or smoking. Liquid wastes from these plants are generally from butchering, can washing, retorting, can cooling, glazing (if freezing is practiced), and from plant cleanup. A distinction is made within this subcategory between remote and non-remote areas (Anchorage, Cordova, Juneau, Ketchikan, Kodiak, and Petersburg are considered non-remote areas).

1.1.17 Alaskan Mechanized Salmon Processing

These Alaskan plants use mechanical butchering machines (iron chinks) on salmon. Plant sizes are much larger than for hand-butchering plants. Some of these large plants may make their own cans. Also, additional operations such as oil production and roe preservation may be included at these plants. Some large plants freeze or grind and cook fish heads for pet foods. Generally, both the quantity of water and waste strength are higher in mechanized plants as compared to the hand-butchered facility. A distinction is made within this subcategory between remote and non-remote areas (Anchorage, Cordova, Juneau, Ketchikan, Kodiak, and Petersburg are considered non-remote areas).

1.1.18 West Coast Hand-butchered Salmon Processing

This subcategory applies to all West Coast plants (Washington, Oregon, and California) that use hand-butchering methods on salmon. Processing methods are generally the same as for Alaskan facilities, with geographical, climate, land, and water differences the basis for a separate subcategorization.

1.1.19 West Coast Mechanized Salmon Processing

This covers all salmon processing plants on the West Coast (Washington, Oregon, and California) with mechanical butchering lines. The rationale for establishing this subcategory separate from the Alaskan mechanized plants also is due to differences in geography, climate, land, and water.

1.1.20 Alaskan Bottomfish Processing

This subcategory was developed to cover all plants processing bottomfish. The industry subcategorization is based on data characteristic of halibut processing including hand-butchering and freezing. A distinction is made within this subcategory between processors located in processing or population centers and remote areas. These population centers include, but are not limited to, Anchorage, Cordova, Juneau, Ketchikan, Kodiak, and Petersburg. This subcategory may be subject to revisions to reflect a greater processing of other bottomfish (Edward C. Jordan 1979).

1.1.21 Non-Alaskan Conventional Bottomfish Processing

These plants process bottomfish outside Alaska using predominately manual methods. The use of scaling machines and/or skinning machines are considered normal processes in these plants. The bottomfish subcategory includes processing of flounder, ocean perch, haddock, cod, sea catfish, sole, halibut, and rockfish. The emerging bottomfish industry (non-mechanized) in Alaska probably is most similar to industries in this subcategory (Edward C. Jordan 1979).

1.1.22 Non-Alaskan Mechanized Bottomfish Processing

These plants process bottomfish outside of Alaska in which the unit operations (particularly the butchering and/or filleting operations) are carried out through mechanized methods. These plants process bottomfish such as whiting and croaker.

1.1.23 Hand-shucked Clam Processing

These plants process clams, with the most significant processing aspect being the hand-shucking of the clams.

1.1.24 Mechanized Clam Processing

These plants process clams with the most significant processing aspect being the mechanical shuckers.

1.1.25 Pacific Coast Hand-shucked Oyster Processing

These are plants located on the west coast that use hand shuckers to process the oysters.

1.1.26 Atlantic and Gulf Coast Hand-shucked Oyster Processing

This subcategory covers plants located on the Atlantic and Gulf coasts that use hand shuckers to process the oysters.

1.1.27 Steamed and Canned Oyster Processing

This subcategory covers plants that process the oysters using mechanical equipment, for all locations.

1.1.28 Sardine Processing

This subcategory covers plants that can sardines or sea herring for sardines. This subcategory as originally proposed did not cover the relatively new steaking operation in which cutting machines are used for preparing fish steaks (Edward C. Jordan 1979). It is probable that the effluent limits for this subcategory cannot be attained by mechanized processors using the technologies evaluated (Edward C. Jordan 1979).

1.1.29 Alaskan Scallop Processing

This subcategory covers plants processing Alaskan scallops. A distinction is made within this subcategory between plants located in population or production centers and remote areas. The population centers include, but are not limited to, Anchorage, Cordova, Juneau, Ketchikan, Cordova, and Petersburg.

1.1.30 Non-Alaskan Scallop Processing

With the exception of land-based processing of calico scallops, this subcategory covers all scallops processed outside of Alaska.

1.1.31 Alaskan Herring Fillet Processing

This covers all Alaskan plants processing herring into fillets. A distinction is made within the subcategory between remote and non-remote categories. Non-remote areas include, but are not limited to, Anchorage, Cordova, Juneau, Ketchikan, Kodiak and Petersburg; remote areas include all other locations. This is an emerging industry and now actually includes other processes such as roe stripping, freezing in the round, and boxing or freezing for use as bait (Edward C. Jordan 1979).

1.1.32 Non-Alaskan Herring Fillet Processing

This covers all plants located outside Alaska which process herring fillets.

1.1.33 Abalone Processing

This subcategory covers all abalone processing in the contiguous states.

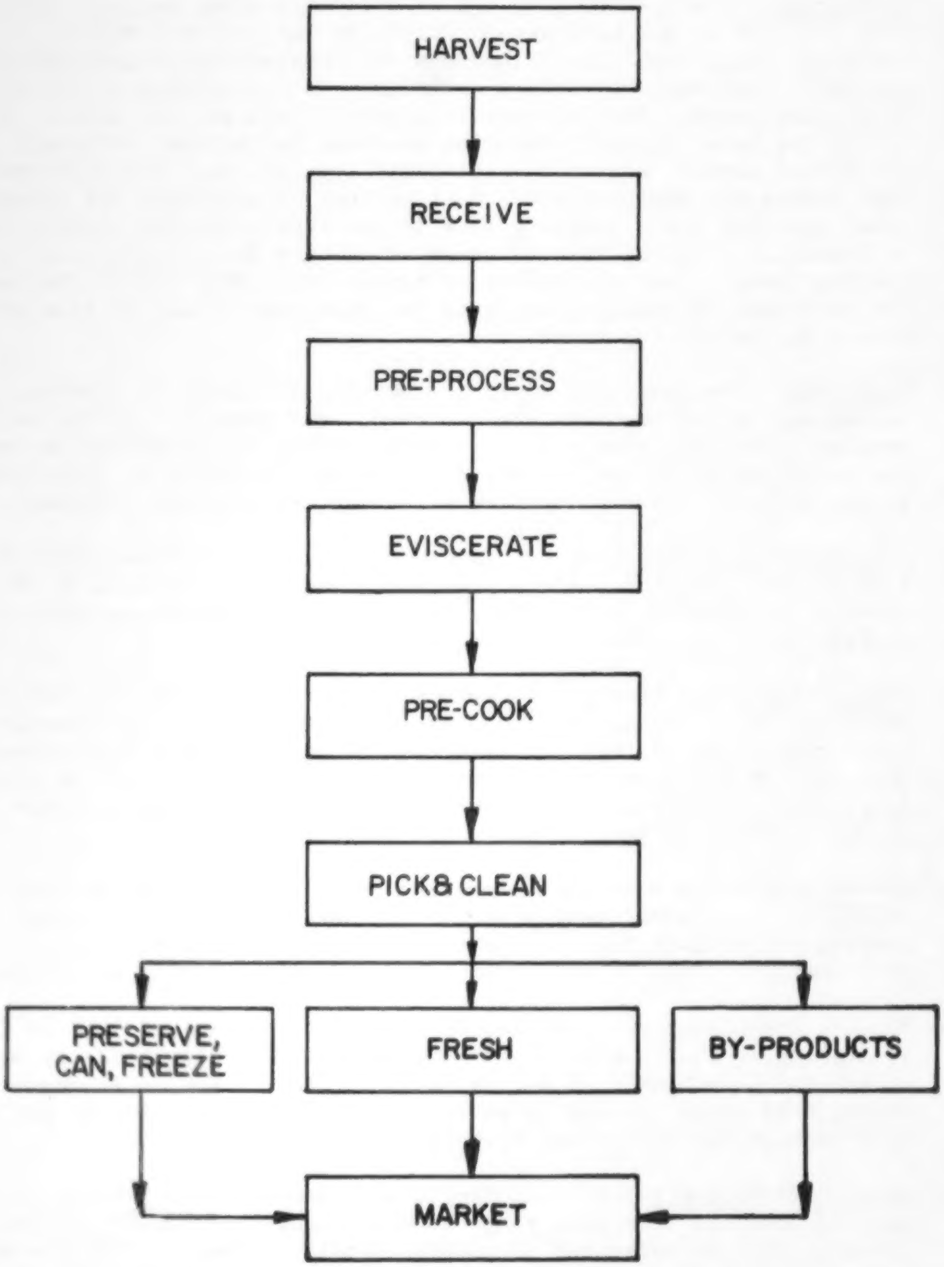
1.2 PROCESSES

There is no standard design for a seafood processing plant; therefore, one can expect to find within each subcategory plants with different methods of production to suit the specific needs of the producer. Several flow diagrams have been included in this section to show the general steps associated with seafood processing and the processes for each subcategory.

1.2.1 Major Processes

The basic processing steps associated with the seafood industry are shown in Figure 1. These are described below in a brief manner to characterize the basic nature of the industry (USEPA 1974a, USEPA 1975b). In addition, the industry includes floating processing plants. These differ from land-based systems in their storage of processed fish, disposal of nonprocess related solid and domestic wastes, fresh water supplies, and electrical needs (Kawabata 1980). These systems are not described or discussed in this document, which

Figure 1. Basic processing sequence for the seafood industry.


HARVEST
RECEIVE
PRE-PROCESS
EVISCERATE
PRE-COOK
PICK & CLEAN
PRESERVE, CAN, FREEZE
FRESH
BY-PRODUCTS
MARKET

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

is intended to describe the impacts of land-based systems subject to New Source Performance Standards.

- Harvesting. The technologies employed in harvesting seafoods range from very old (e.g., sail-driven skipjacks for oyster dredging) to very new (e.g., high seas tuna clippers with computer-driven navigation systems). Although harvesting techniques vary according to the seafood being sought, fishing vessels generally utilize the latest technology for locating and harvesting seafoods in the most efficient and economical manner consistent with local regulations. The techniques most frequently employed are: netting (use of gill nets for salmon or trawl nets for cod), trapping (use of pot type traps for shrimp, crab, or lobster), dredging (use of tongs or dredges for oysters), and line fishing (long lines for halibut or black cod). Once aboard the vessel, the catch may be taken directly to the processor or may be iced or frozen for processing later.

- Receiving. The receiving operation usually involves three steps: unloading the vessel, weighing the catch, and transport to the processing or holding area. At some point during the receiving operation the catch may be sorted, either to facilitate payments to fishermen or to separate the catch by species before processing (e.g., salmon).

- Preprocessing. Preprocessing refers to the initial preparation of fish or shellfish for the processing sequence. It may include washing, thawing, sorting out trash fish, or any other processes to prepare the seafood for butchering.

- Evisceration. At this point, organs and other parts of the fish or shellfish which are not intended for human consumption are removed by butchering. Wastes from the evisceration process are either screened from the waste stream or dry captured. The wastes then may be either processed into a by-product; taken to a landfill; ground and discharged; or barged to deep water and dumped.

- Pre-cooking. The pre-cooking process, which facilitates the removal of skin, bones, shell, and other parts, may be practiced in order to prepare the product for the picking and cleaning operation (e.g., the pre-cooking of crab before picking the meat for freezing or canning).

- Picking and Cleaning. The fish or shellfish is prepared for the final processing by the removal of non-edible from edible portions by manual or mechanical methods, or a combination of both. Wastes generated during this operation may be saved for by-product recovery or may be sent through any of several disposal processes.

- By-product Recovery. Because by-product recovery from seafood processing consists of a wide range of processes, this segment of the industry will be addressed in greater detail in Chapter 3.0 of these Guidelines. A few examples would be the rendering of fish livers for oil; burning of shells for lime; and production of fish meal from viscera. An important segment of the industry includes the manufacture of industrial fishery products such as fish meal, concentrated protein solubles, oils, liquid fish fertilizers, fish feed pellets, shell novelties, kelp products, and pearl essence. Fish meals are utilized as protein supplements in animal feeds. The oil which is exported is used in margarine and shortenings. In the domestic market, fish oils are used for protective coatings, lubricants, cosmetics, soaps, and medicinals. Some fish solubles are used as liquid fertilizer. Oils and solubles are also combined with fish meal for animal feed.

The specific processing steps at a facility are selected according to the desired product and ultimate market. For the fresh seafood market, the product is packed in a suitable container and held under refrigeration until shipment. Those products not destined for the fresh seafood market are preserved by freezing, canning, pickling, salting, drying, smoking, or combinations of these processes:

- Freezing. An excellent method for holding some seafoods as the meat essentially is unchanged. Autolysis, the breakdown of tissue by self-contained enzymes, still occurs in frozen products but at a reduced rate. Some seafood must be consumed within 6 months from freezing, while others may be held for several years. Blanching before freezing inactivates many enzymes and further reduces the rate of autolysis.

- Canning. Preservation by canning requires special equipment to fill cans, add seasonings and preservatives, create a partial vacuum, and seal the can. The partial vacuum is necessary to reduce distortion of the can during cooking and cooling. After sealing, the cans are retorted (pressure cooked) at 150°C (240°F) for periods of 30 to 60 minutes. After cooking the cans are cooled with water or air and then labeled and boxed. The high temperature and long duration time for retorting is to ensure that spores of the harmful anaerobic bacteria Clostridium botulinum are totally destroyed.

- Pickling. Preservation by pickling is accomplished by adding seasonings and preservatives to the product and allowing the solution to penetrate into the product. After the pickling process, the product may be packed in glass or plastic containers and refrigerated.

- Salting. In this method liberal quantities of salt are applied to the product and the liquids allowed to drain from the meat.

- Drying. This method uses warm dry air to remove moisture from the product until it is dry enough to resist bacterial attack. The dried or salted products may be packed in a variety of containers such as metal cans, glass jars, wooden boxes, and plastic containers.

- Smoking. Preservation by smoking generally involves pre-treatment by a dry or wet partial pickling process followed by drying and exposure to a non-rosinous wood smoke to dry the product and impart a smokey flavor to the product. After smoking, the product may be packaged in metal cans or in plastic. Plastic packages are generally refrigerated or frozen to reduce autolysis and bacterial decomposition.

1.2.2 Process Descriptions for the Industry Subcategories

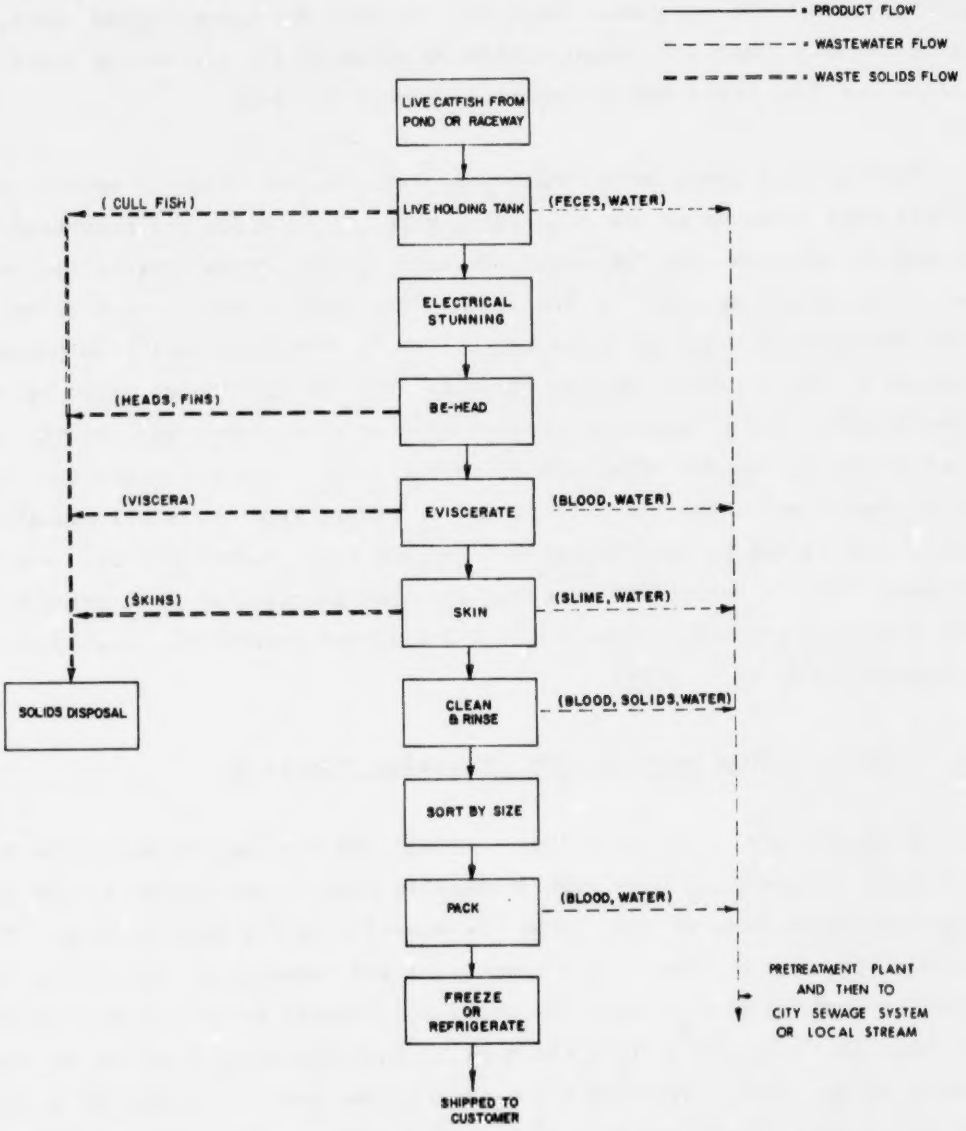
Although there are 33 subcategories identified for the seafood industry, the unit processes are the same for several subcategories where the basis for subcategorization lies with other factors (e.g., location). Where this occurs only one diagram is presented and any substantial differences are noted.

1.2.2.1 Farm Raised Catfish Processing (Figure 2)

Live catfish enter the plant through the receiving area where they are culled, weighed, and stored either in live tanks or in iced storage pending processing. When ready for processing, the fish are placed in water tanks or dewatered cages and are electrocuted. Usually heads are removed with bandsaws or table saws. The heads, decomposed fish, and culled fish are then dry captured (i.e., a system that does not use water to transport these materials). Evisceration is next accomplished by manually opening the body cavity and removing the viscera by hand or with a vacuum system. Most plants employ a dry capture method for the viscera. The skins are then removed from the catfish by either mechanical or manual means. For manual skinning the catfish is impaled on a hook over the work area and a tool similar to pliers is used to pull the skin off the fish. Mechanical skinning involves running the fish over a machine similar to a planer which abrades and pulls the skin from the fish. The skins are flumed to the main waste stream or trapped at the skinner in baskets.

After butchering, the fins and remnant pieces of skin are removed. The fish are then washed by manual or automatic washers and a rotating brush is used to clean the body cavity. After a final rinse the fish are graded and inspected. Those under 0.45 kg (one pound) are packed in ice and refrigerated or frozen for shipment. Some plants may package these smaller individual fish in plastic coated trays for the retail market. The fish over 0.45 kg (one pound) are either steaked or filleted. The bulk of the product is shipped as either fresh or frozen whole fish, although a small market exists for fresh or frozen fillets and for frozen breaded catfish sticks.

Figure 2. Flow diagram for a typical farm raised catfish processing plant.



PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
LIVE CATFISH FROM POND OR RACEWAY
LIVE HOLDING TANK
(CULL FISH)
(FECES, WATER)
ELECTRICAL STUNNING
BE-HEAD
(HEADS, FINS)
EVISCERATE
(VISCERA)
(BLOOD, WATER)
SKIN
(SKINS)
(SLIME, WATER)
SOLIDS DISPOSAL
CLEAN & RINSE
(BLOOD, SOLIDS, WATER)
SORT BY SIZE
PACK
(BLOOD, WATER)
FREEZE OR REFRIGERATE
SHIPPED TO CUSTOMER
PRETREATMENT PLANT AND THEN TO CITY SEWAGE SYSTEM OR LOCAL STREAM

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020, Washington DC.

1.2.2.2 Conventional Blue Crab Processing (Figure 3)

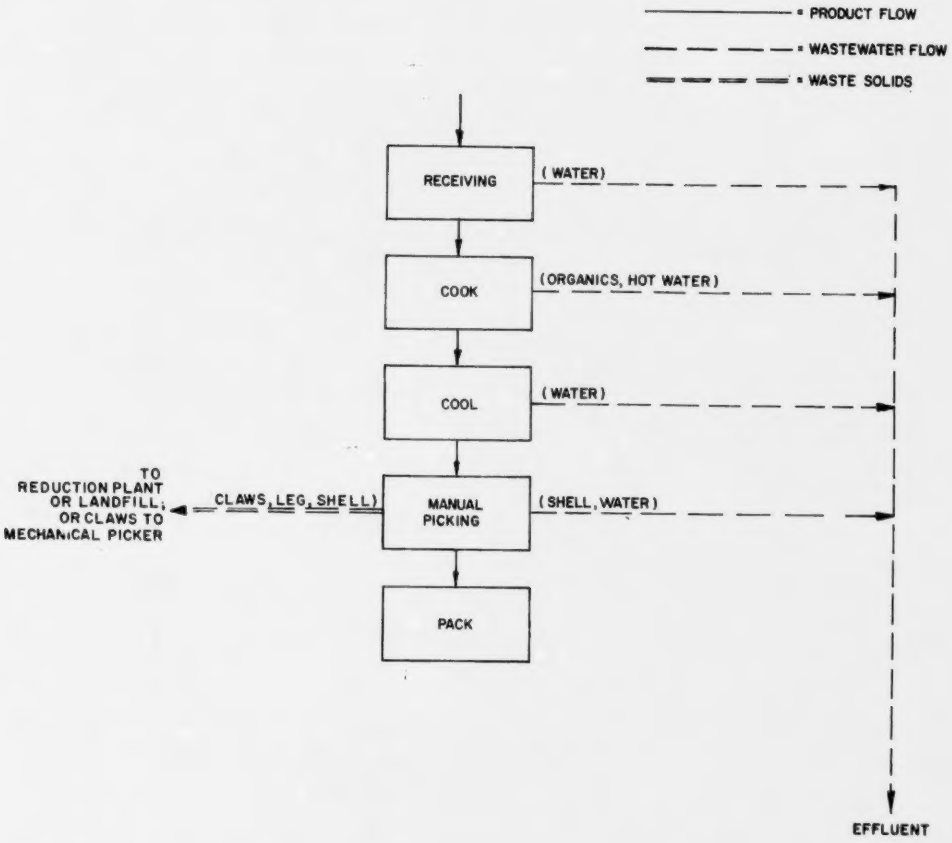
Blue crabs generally are much smaller than crab varieties processed on the west coast of Alaska. The size ranges from 11-13 cm (4.5 - 5 inches) measured across the carapace. Mortality is high for transshipped crabs; therefore most crabs are caught within 50 miles of the processing plant. When catches are low, crabs may be imported from other areas.

Because dead crabs deteriorate very rapidly, the catch is sorted immediately when received at the processing plant. (If crabs are harvested during the molting process, the "peelers" are kept in live boxes and checked every four hours until the shell is discarded. The crab is then packed in wet sea grass and marketed live as "soft shell crab.") The crabs are then placed in steamers at 121°C (250°F) for 10 minutes. (On the Gulf Coast crabs are sometimes boiled; this practice is frowned upon in some states because the temperature is too low for effective microbial kill.) After cooking the crabs are butchered manually, the meat picked or shaken from the shell manually, cooled, and packed in snap lid cans. For the fresh market the cans are iced, but most cans are hermetically sealed and then pastuerized in a water bath at 89°C (192°F) for about 110 minutes. A few plants process the crab meat by canning followed by a retort.

1.2.2.3 Mechanized Blue Crab Processing (Figure 4)

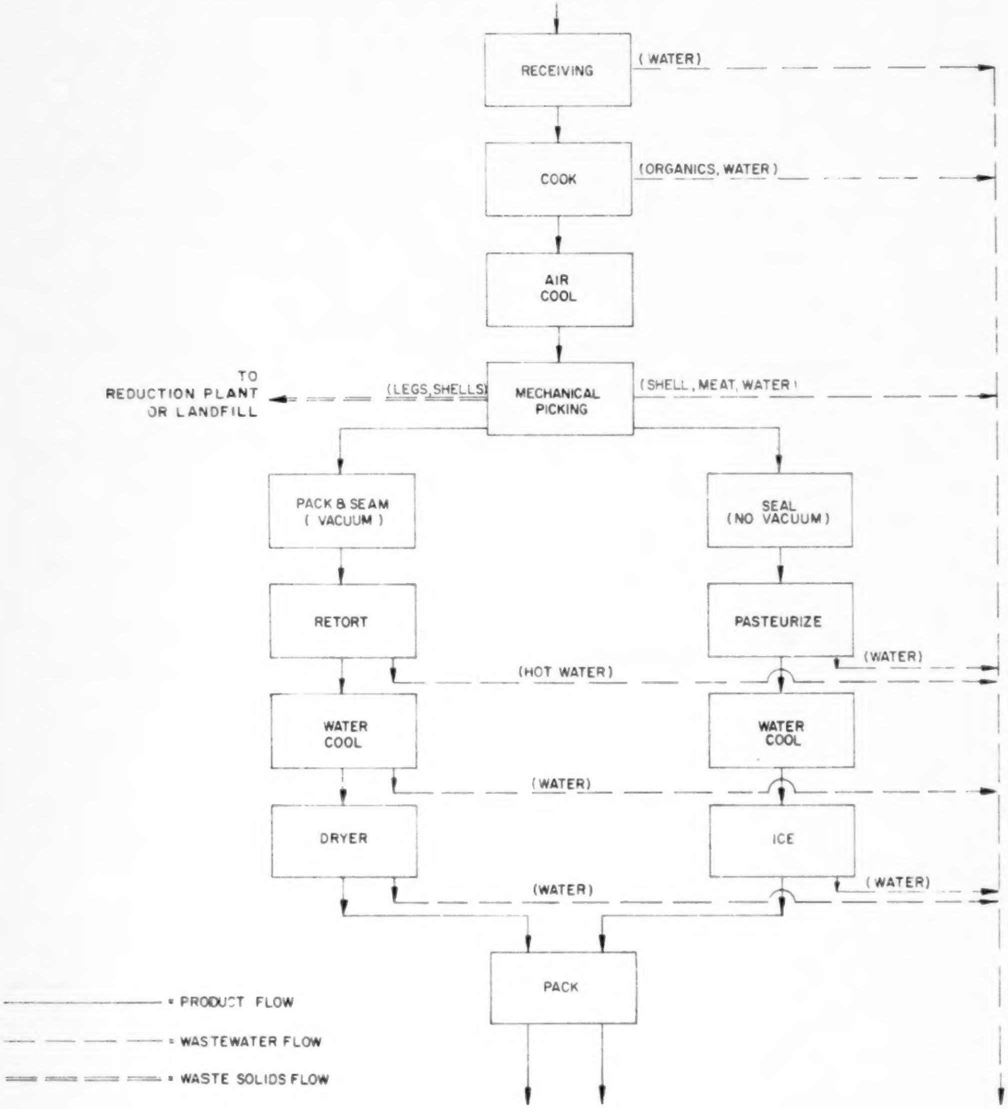
In these plants the receiving, cooking, and cooling processes are the same as in conventional blue crab processing plants, but differ at the picking stage where a mechanical claw picker is substituted for hand-picking. This mechanism breaks the claw with a hammermill and immerses it in a brine tank where the meat is floated from the shell and removed in the brine overflow. The shell is then removed from the tank by an inclined belt moving countercurrent to the meat. Although a few plants also use the mechanical picker on body meat, most plants use hand pickers for this purpose. The back or "lump fin" meat is packed and sold as a premium product by mechanized crab processing plants. These processors also can and retort a larger portion of their crab than do hand pickers, who generally fresh pack or pastuerize the meat.

Figure 3. Flow diagram for a typical blue crab conventional processing plant.


= PRODUCT FLOW
= WASTEWATER FLOW
= WASTE SOLIDS
RECEIVING
(WATER)
COOK
(ORGANICS, HOT WATER)
COOL
(WATER)
MANUAL PICKING
(SHELL, WATER)
CLAWS, LEG, SHELL)
TO REDUCTION PLANT OR LANDFILL; OR CLAWS TO MECHANICAL PICKER
PACK
EFFLUENT

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

Figure 4. Flow diagram for a typical blue crab mechanized processing plant.


RECEIVING
(WATER)
COOK
(ORGANICS, WATER)
AIR COOL
TO REDUCTION PLANT OR LANDFILL
(LEGS, SHELLS)
MECHANICAL PICKING
(SHELL, MEAT, WATER)
PACK & SEAM (VACUUM)
SEAL (NO VACUUM)
RETORT
PASTEURIZE
(WATER)
(HOT WATER)
WATER COOL
WATER COOL
(WATER)
DRYER
ICE
(WATER)
(WATER)
PACK
= PRODUCT FLOW
= WASTEWATER FLOW
= WASTE SOLIDS FLOW

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

1.2.2.4 Alaskan Crab Meat Processing: Remote and Non-Remote (Figures 5 and 6)*

Crabs are brailed (i.e., hoisted in a dip net) from the live tanks of the catch boat; female or dead crabs are discarded, and the remaining catch is weighed. After weighing, the crabs are placed in holding tanks filled with seawater in which the dissolved oxygen level is maintained by circulating fresh seawater from the bay.

When the butchering process begins, the crabs are grasped by the legs on each side and with a swift downward swing the butcher strikes the crab midline bottom over a sharpened quarter circle metal blade. The viscera fall into a container, the carapace is separated as a single piece, and the halved sections are then sent to be degilled. (If the crab tail is to be processed into crab steaks it is removed from the carapace at this point.) Degilling is done either by a rotary wire brush or a paddle wheel which brushes the gills from the body shell. The paddle wheel may be used to butcher and degill in one operation. The degilled sections are further processed by removing the legs from the body (shoulders) with a saw. The butchered crab parts are then precooked at 60-65°C (140-150°F) for 4 to 5 minutes. After precooking, these processors may either collect claws intact and freeze them for marketing or blow out the claw meat and meat from the larger legs with strong water jets. The shoulder and remaining leg meat is squeezed from the shell by passing the parts through rubber rollers very similar to washing machine wringers. The shells are removed from the rollers by flume and the meat is hand-picked to remove pieces of broken shell and other detritus.

After butchering the meat is sorted into three categories: claw meat, leg meat, and shredded meat. The meat is again cooked at 93° to 99°C (200° to 210°F) for 8 to 12 minutes, rinsed, and cooled with fresh water. The meat is then packed into 6.8 kg (15 lb) capacity trays. A saline or ascorbic acid solution may be added to the trays to improve taste and color, but this step

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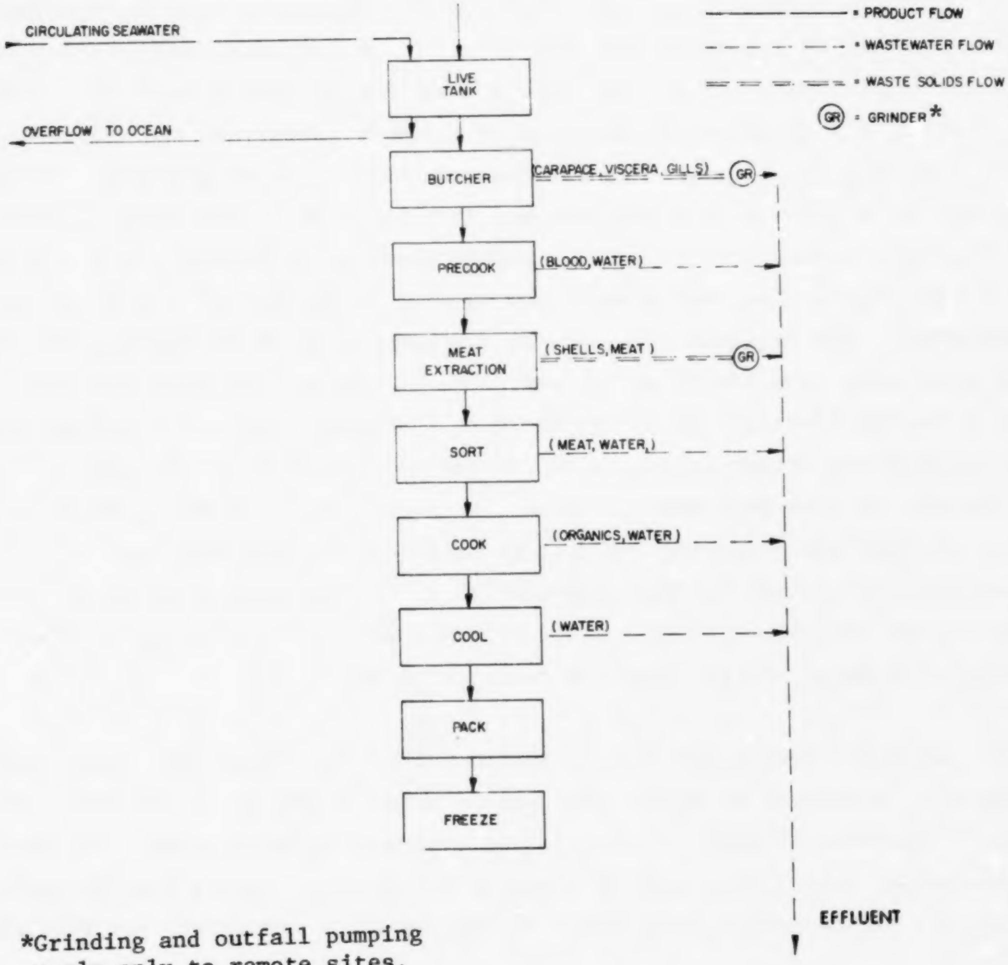
*This processing method is essentially the same for plants located in both remote and non-remote areas.

Figure 5. Flow diagram for a typical Alaskan crab frozen meat processing plant.

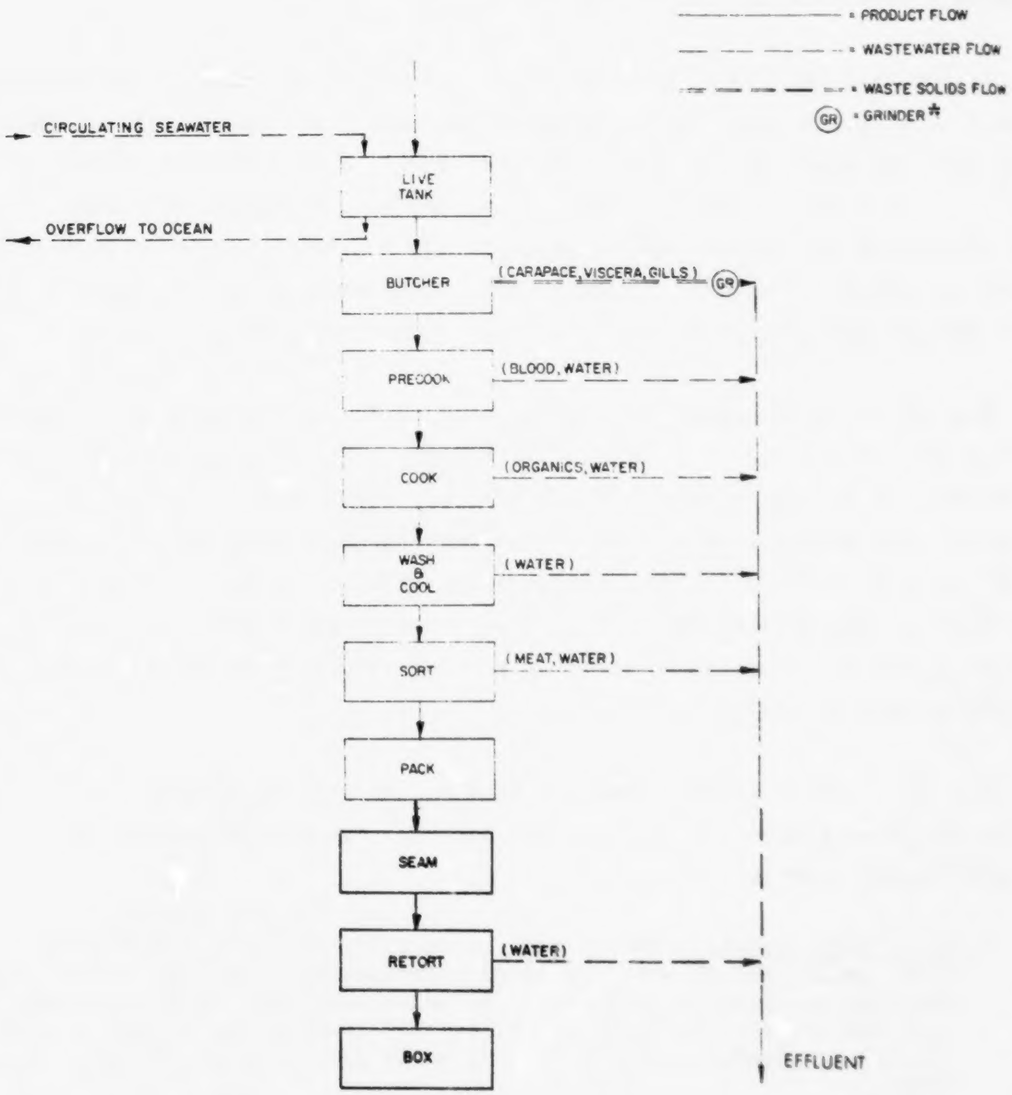


CIRCULATING SEAWATER
LIVE TANK
OVERFLOW TO OCEAN
BUTCHER
(CARAPACE, VISCERA, GILLS)
GR
PRECOOK
(BLOOD, WATER)
MEAT EXTRACTION
(SHELLS, MEAT)
GR
SORT
(MEAT, WATER,)
COOK
(ORGANICS, WATER)
COOL
(WATER)
PACK
FREEZE
EFFLUENT
= PRODUCT FLOW
= WASTEWATER FLOW
= WASTE SOLIDS FLOW
GR = GRINDER*

*Grinding and outfall pumping apply only to remote sites.

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

Figure 6. Flow diagram for a typical Alaskan crab canning processing plant.



= PRODUCT FLOW
= WASTEWATER FLOW
= WASTE SOLIDS FLOW
GR = GRINDER*
CIRCULATING SEAWATER
LIVE TANK
OVERFLOW TO OCEAN
BUTCHER
(CARAPACE, VISCERA, GILLS)
GR
PRECOOK
(BLOOD, WATER)
COOK
(ORGANICS, WATER)
WASH & COOL
(WATER)
SORT
(MEAT, WATER)
PACK
SEAM
RETORT
(WATER)
BOX
EFFLUENT

*Grinding and pumping to outfall apply to remote sites only.

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

varies from processor to processor. The trays of meat are then frozen, and the blocks of meat removed for glazing and boxing. The blocks may be cut into smaller portions for the retail market before glazing and boxing. Figure 5 includes a schematic diagram of the process.

If the crab meat is to be canned, the process is the same as for freezing through sorting. At that point the meat is packed into cans usually of 184 grams (6.5 oz) capacity. A sodium chloride-citric acid tablet is placed in each can, a vacuum is drawn, and the lid sealed with an automatic seamer. The cans are placed in baskets, and retorted at 116°C (240°F) for 50 to 60 minutes, cooled in water, and allowed to dry before boxing and shipping. Figure 6 shows the process diagram for the king and tanner crab canning process.

Some crab plants employ two cooking periods during the processing operation--a precook as well as final cook. When the precook is used, it is designed to firm the meat, rinse off the residual blood from the butchering operation, and minimize heat shock of the subsequent cooking step. Precooking at 60° to 66°C (140° to 150°F) normally lasts from one to five minutes. The main cook is conducted at about 99°C (210°F) for 10 to 20 minutes. Salt usually is added to the cooker water in concentrations of 50,000 to 60,000 mg/l NaCl (as chloride).

The two types of cookers commonly used by the crab processing industry in Alaska are distinguished by product flow and are termed either batch cookers or flow-through cookers.

- Batch-type Cookers. These range in size from 0.76 to 3.8 m^3 (200 to 1,000 gal). Makeup water is added periodically to replace losses from evaporation, product carryover, and water overflow. Steam normally is employed to heat the tanks to the desired temperature. These cookers usually are drained and the cooking water replaced once or twice per shift.

- Flow-through Cookers. Also called "continuous cookers," these range in size from 1.9 to 9.5 m^3 (500 to 2,500 gal). The crabs are conveyed through the cooker on a stainless steel mesh belt. Nearly all flow-through cookers in Alaska employ steamheated hot water, although at least one plant is known to steam cook directly. Like batch cookers, flow-through cookers (other than steam cookers) are drained and refilled one to two times per shift. Some variations in the process exist. For example, the ungilled crab sections are sometimes cooked at a temperature of 93°C (200°F) for 10.5 minutes; degilled; the legs separated from the shoulders and split by saw; and the meat manually removed. Other processors hand-shake the meat from the shells.

The major differences in processing the different types of crabs is in the cooking times and use of rollers for shelling. Because tanner crab shells are harder than king crab shells, rollers are used almost exclusively. Dungeness crab usually is processed and marketed as whole cooked crab. If processed for meat, the system is generally the same as for tanner or king crabs except cooking time is reduced for the smaller dungeness. Meat separation is by manual shaking in many plants.

1.2.2.5 Alaskan Whole Crab and Crab Section Processing: Remote and Non-Remote (Figure 7)*

Dungeness crabs generally are sold as whole cook crabs (i.e., all legs and claws are attached). The majority of the king and tanner crabs are sold as sections or crab meat, although some kings and tanners are sold as whole cooks for the local retail markets. The whole crabs go directly from the live tank to the cookers. After cooking at 99°C (210°F) for 18 minutes the crabs are cooled, packed, and frozen for market. If the crabs are to be sold as fresh whole cooked crab, the crabs are boxed after cooling and refrigerated until shipment.

Crabs with missing appendages usually are processed as sections or crab meat. Crab sections are prepared by the same butchering process as for crabs going into crab meat (Section 1.2.2.4), except the legs are not cut from the shoulders. Cracked shells and sections with missing legs are sent to the meat line for picking. If parasites (sea lice or barnacles) are present, the shells are cleaned by hard brushing.

The crab halves (or sections) are placed in wire racks and precooked at 60° to 70°C (140° to 160°F) for 2 to 5 minutes. The crabs are then cooked near boiling for 18 minutes. After cooking the sections are rinsed and

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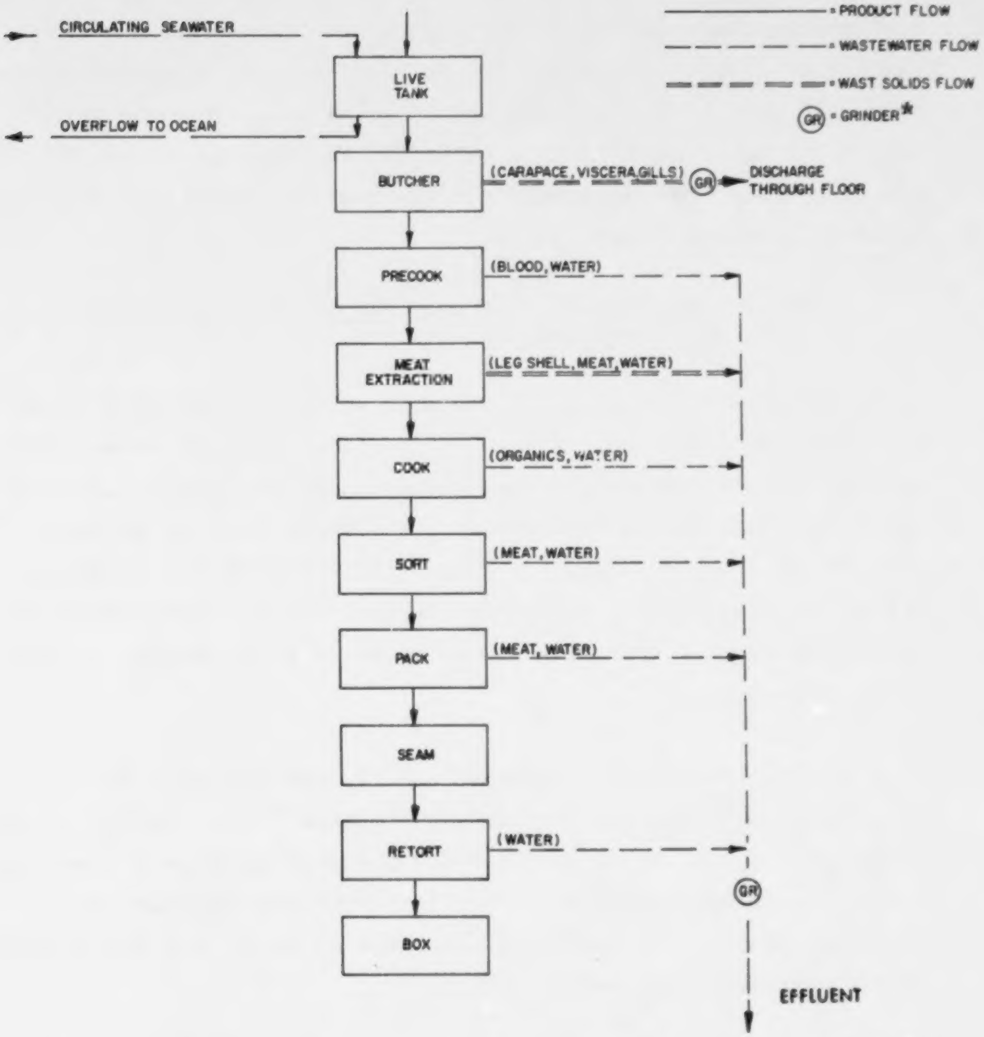
*There is no significant difference in remote and non-remote processing. The subcategories were separated because of the increased effect of processing plant waste loads in populated areas.

Figure 7. Flow diagram for a typical Alaskan crab sections processing plant.



CIRCULATING SEAWATER
OVERFLOW TO OCEAN
LIVE TANK
BUTCHER
PRECOOK
MEAT EXTRACTION
COOK
SORT
PACK
SEAM
RETORT
BOX
(CARAPACE, VISCERA,GILLS)
GR
DISCHARGE THROUGH FLOOR
(BLOOD, WATER)
(LEG SHELL, MEAT, WATER)
(ORGANICS, WATER)
(MEAT, WATER)
(MEAT, WATER)
(WATER)
GR
EFFLUENT
= PRODUCT FLOW
= WASTEWATER FLOW
= WAST SOLIDS FLOW
GR = GRINDER*

*Note - grinder refers to remote facility only; non-remote facility requires treatment prior to discharge.

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

cooled either by a cold water spray or immersion in a dip tank. The cooled sections either may be separated into individual legs before packing or packed as half crab sections. Aluminum foil or plastic may be placed over the meat end of the sections to prevent drying for both the fresh and frozen market. The sections are then frozen, glazed, and boxed.

1.2.2.6 Dungeness and Tanner Crab Processing in Contiguous States

The dungeness and tanner crab processing industry along the West Coast is much smaller than that of Alaska. The predominant species processed is the dungeness crab; tanner crabs, which are not native to the region, are received from Alaska only during surplus periods. Most crabs are either cooked whole or cooked and then picked for crab meat. Process lines and processes are nearly identical to the Alaskan processes (See Figures 5 and 6). Most dungeness harvesters sail daily to tend their pots and return by evening to the processing plant. The crabs are kept in live tanks so that they remain in excellent condition, but they are stored dry overnight as this tends to reduce their aggressiveness and seems not to increase mortality.

Crabs for whole cooking are inspected to ensure that they have all their legs and claws. They are then boiled 20 to 30 minutes in a solution containing 50,000 to 60,000 mg/l NaCl (as chloride) for seasoning and 650 to 800 mg/l citric acid to facilitate shell cleaning. The cooked crabs are cooled in a coldwater spray or by immersion in a tank filled with cold water. The crab shells are cleaned to remove external parasites, the legs are tucked tightly under the crab, and it is frozen in either a brine freezer or a blast freezer. The frozen crab is glazed and packed for the retail market. If the crab is to be marketed as fresh crab, the freezing is omitted.

If the crab is to be processed into crab meat, the crab is butchered by striking the crab across the edge of a sharpened metal plate similar to the method for king and tanner crabs (See Section 1.2.2.4). The carapace is then removed and the legs are separated from the shoulder. The crab pieces may be either spray washed or packed in steel baskets and submerged in circulating water. The crab parts are then cooked in boiling water for approximately 12 minutes. The cooling process is either by cold water spray or by placing the baskets of cooked parts in circulating cold water. After cooling, the meat is picked manually with yields ranging from 17 to 27% of live weight. As with blue crab the shell fragments are removed in a brine tank. The meat is then rinsed and drained followed by packing for the fresh or frozen meat markets; for the canned market it is packed in cans along with seasonings. The filled cans are mechanically seamed and washed, retorted, cooled and dried, and packed into cartons.

1.2.2.7 Alaskan Shrimp Processing: Remote and Non-Remote (Figures 8 and 9)

The three species of shrimp of commercial importance in Alaska are the pink shrimp (*Pandalus borealis*), the side-stripe shrimp (*Pandalopsis dispar*), and the coon-stripe shrimp (*Pandalus hypsinotus*). The Alaskan shrimp industry depends primarily on trawling, although some fishermen use pots to catch shrimp, generally in areas where trawling is impractical because of rough bottom conditions. Pot shrimp usually find their way into the retail market as whole cooked shrimp or snapped shrimp tails.

The peak shrimp season is from mid-June to mid-September, although processing occurs intermittently throughout the year. The bulk of the catch is processed by using mechanical peelers which can handle from 1,820 to 5,450 kg (4,000 to 12,000) lbs) of shrimp per day. Hand processing of shrimp is generally limited to very small processors who cater directly to the retail market.

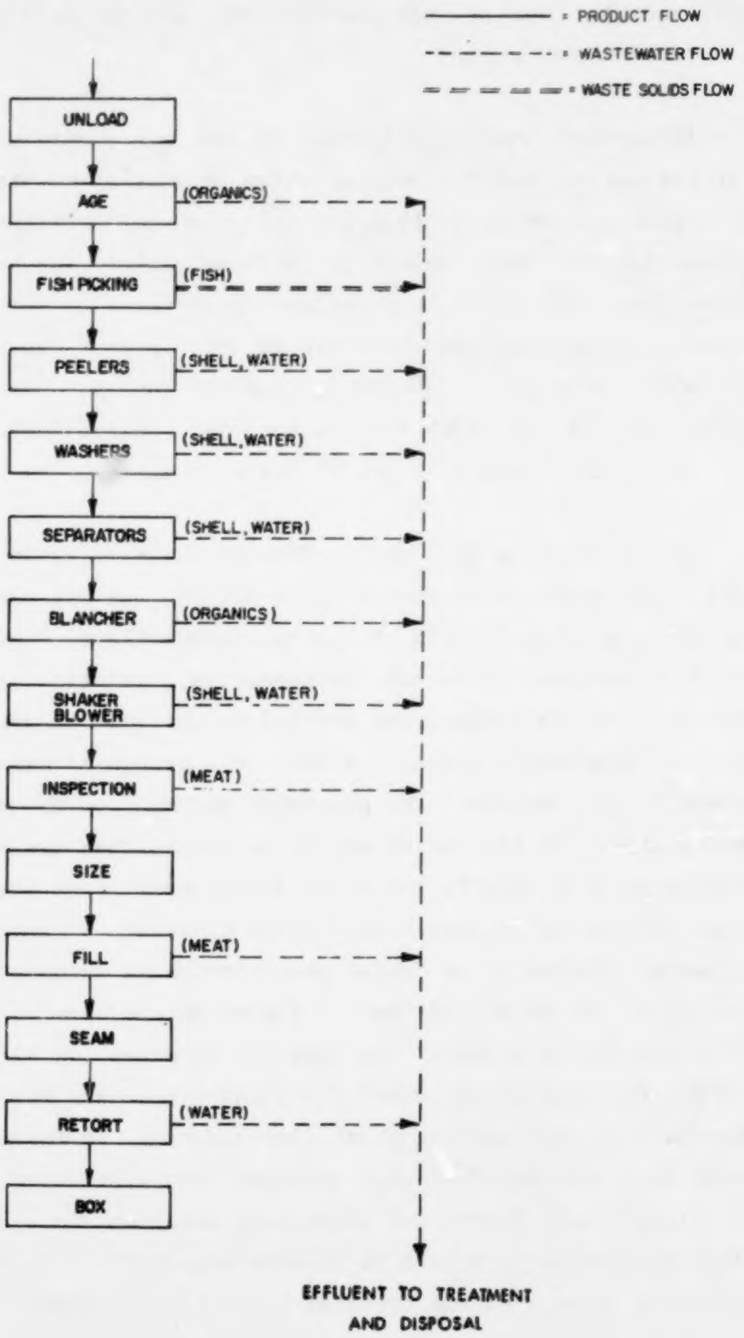
Shrimp may be held on ice several days before delivery to the processing plant. After receipt at the plant, the shrimp may be held several more days under refrigeration to condition them for mechanical peeling. Fish which are accidentally caught in the trawls are manually separated and discarded. (Efforts are being made to utilize these fish or to use fish-proof trawls.)

Most plants have from four to nine machine peelers each of which uses about 380 l (100 gal) of process water per minute. The machines used in Alaska are generally either a Model PCA or a Model A, both manufactured by the Laitram Corporation, New Orleans, Louisiana. The Model PCA peeler employs a 1.5 minute steam precook to condition the shrimp before peeling. This process facilitates peeling and increases the rate of production of shrimp because the shells are loosened. Shrimp from this peeler almost always are frozen. The Model A peeler does not use the pre-cook, and the meat from this machine is either canned or frozen.

The shrimp, whether precooked or raw, are evenly distributed on a broad belt and passed into the peelers which consist of counter-rotating rollers which grab the shrimp feelers and roll the shell off the meat. The shrimp are pressed against these rollers by overhead racks. The heads and shells are flushed from the peelers with either fresh water or seawater. The Model A peeler processes approximately 400 kg (900 lbs) of raw product per hour while the Model PCA produces 230-270 kg (500-600 lbs) per hour. Although the production rate of the Model A is much higher, the product from the Model PCA is believed by the industry to be of better quality.

The shrimp move from the peelers to the next washers by either belt or flume. The types of washers used in Alaska, one for raw shrimp and one for precooked, account for 20% of the wastewater flows. The Laitram Model C washer is designed to detach "swimmerettes," gristle, shell, and other waste material from raw shrimp; the Model A is designed to wash peeled precooked shrimp by vigorously mixing the meat in a trough to separate any shell not removed by the peelers. The precooked shrimp from the Model A peelers are then drained. If the shrimp are to be canned they are blanched in a salt solution at 96°C (205°F) for 15 to 17 minutes. Some plants then run the shrimp through an up flow blower which dries the shrimp and removes shell fragments. Shrimp to be canned pass through an automatic can filler. A solution of ascorbic acid then is placed in the cans as a color preservative before the can is seamed. The cans are retorted for 20 to 25 minutes at 116°C (240°F), then cooled and cased (24 eight-ounce cans per case). Figure 8 presents a typical canning plant flow diagram. Shrimp for freezing are either rinsed in a salt-ascorbic acid solution before freezing or directly frozen. Some plants blast freeze and glaze individual shrimp before bagging. Some plants bag shrimp in 1 to 5 lb plastic bags or in 5 lb containers. Figure 9 presents a typical shrimp freezing plant flow diagram.

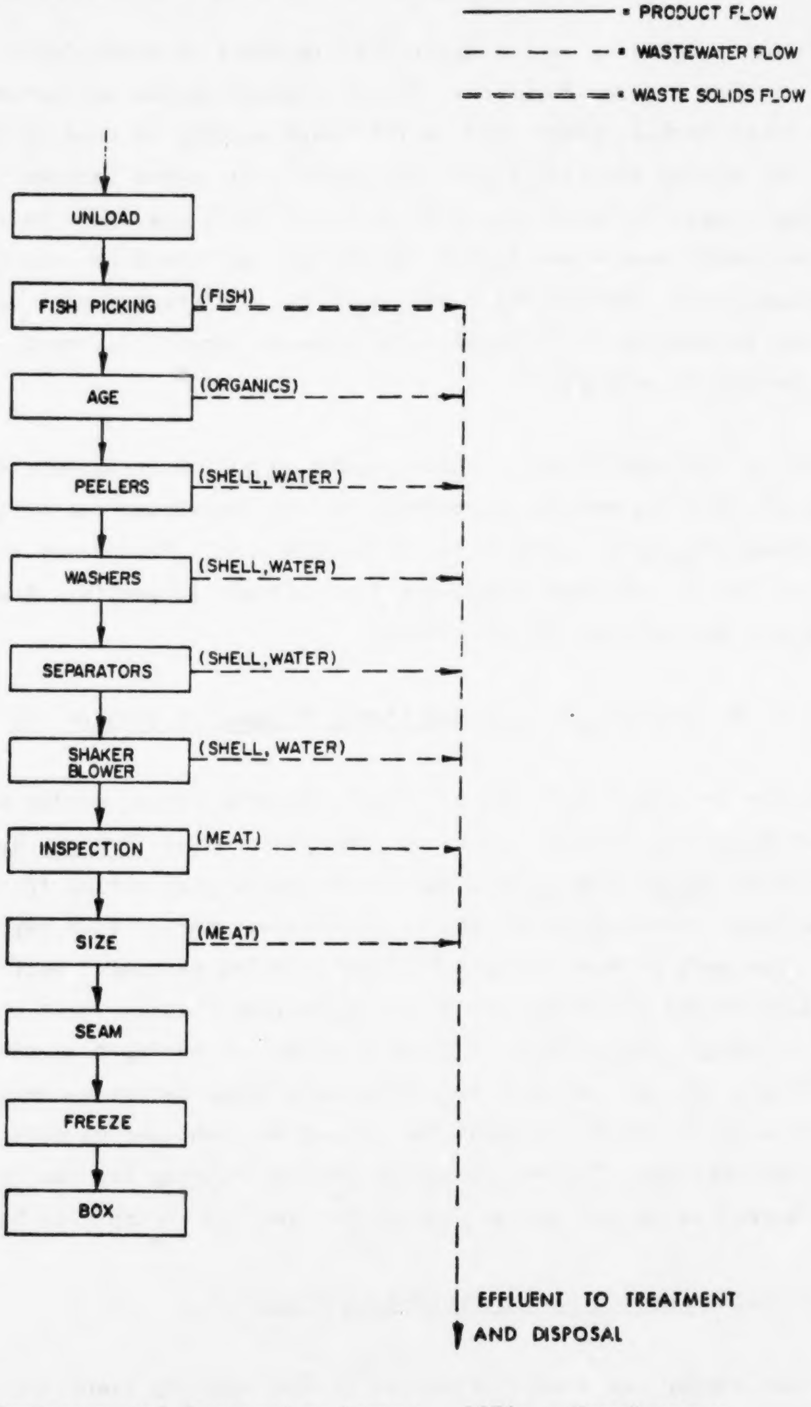
Figure 8. Flow diagram for a typical Alaskan shrimp canning processing plant.



= PRODUCT FLOW
= WASTEWATER FLOW
= WASTE SOLIDS FLOW
UNLOAD
AGE
(ORGANICS)
FISH PICKING
(FISH)
PEELERS
(SHELL, WATER)
WASHERS
(SHELL, WATER)
SEPARATORS
(SHELL, WATER)
BLANCHER
(ORGANICS)
SHAKER BLOWER
(SHELL, WATER)
INSPECTION
(MEAT)
SIZE
FILL
(MEAT)
SEAM
RETORT
(WATER)
BOX
EFFLUENT TO TREATMENT AND DISPOSAL

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

Figure 9. Flow diagram for a typical Alaskan shrimp freezing processing plant.



PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
UNLOAD
FISH PICKING
(FISH)
AGE
(ORGANICS)
PEELERS
(SHELL, WATER)
WASHERS
(SHELL, WATER)
SEPARATORS
(SHELL, WATER)
SHAKER BLOWER
(SHELL, WATER)
INSPECTION
(MEAT)
SIZE
(MEAT)
SEAM
FREEZE
BOX
EFFLUENT TO TREATMENT AND DISPOSAL

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

1.2.2.8 Northern Shrimp Processing in the Contiguous States

Shrimp processing on the upper Pacific Coast is essentially the same as in Alaska (See Figures 8 and 9). One difference in the harvesting of shrimp on the lower Pacific Coast area is the rough sorting on deck to remove trash fish. The shrimp are then placed in the hold in layers between ice. Rarely do shrimp remain on board vessel more than 1 to 2 days after being caught. There are still some trash fish to be removed and these are separated at the processing plant. Both Model A and Model PCA peelers are used on the West Coast and processing is the same as in Alaska, except that most plants use fresh instead of salt water.

In the New England area, shrimp boats unload their harvest daily. At the dock trash fish and debris are removed before the shrimp are weighed and iced. The predominate peeler used is the Model PCA type. Shrimp may be processed as canned or frozen and some shrimp are fresh frozen in shells. Fresh water is used almost exclusively for processing.

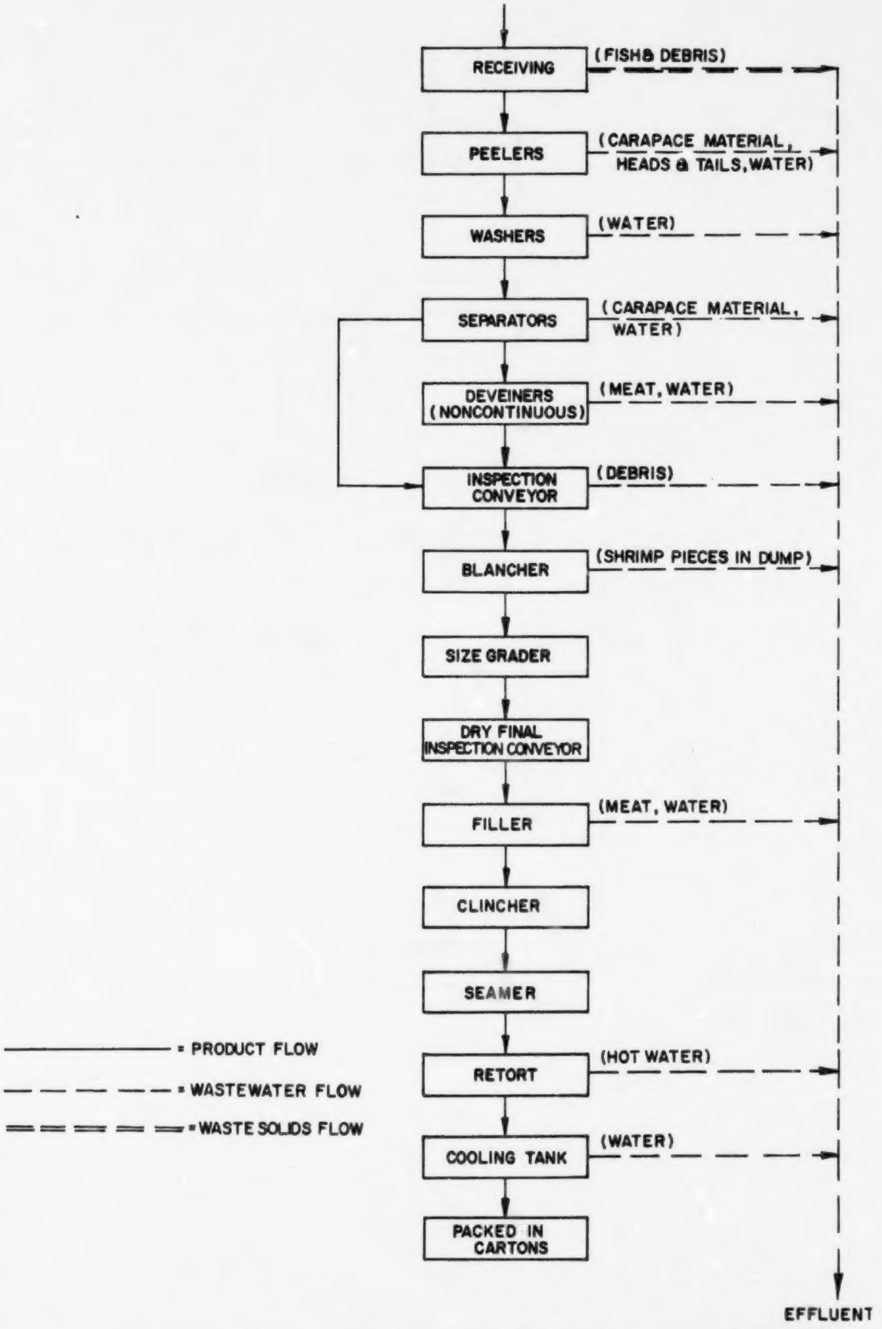
1.2.2.9 Southern Non-breaded Shrimp Processing (Figure 10)

In the Gulf of Mexico and the South Atlantic areas, shrimp processing is the most important seafood industry. The pink shrimp (*Penaeus duorarum*), the brown shrimp (*Penaeus aztecus*), and the white or gray shrimp (*Penaeus setiterus*) are the three most important species processed. Shrimp also may be imported from as far away as North Africa or Indonesia for canning. Gulf Coast fishermen generally deliver the shrimp to a central buying station where the shrimp are loaded directly onto trucks. A large quantity of shrimp from the South Atlantic and Gulf are beheaded at sea, to slow product degradation and allow a longer time at sea. In a few instances the shrimp are beheaded on dock before being loaded onto trucks. The processing of southern shrimp for the frozen and canned market is basically the same as for Alaskan shrimp (See Section 1.2.2.7).

1.2.2.10 Breaded Shrimp Processing (Figure 11)

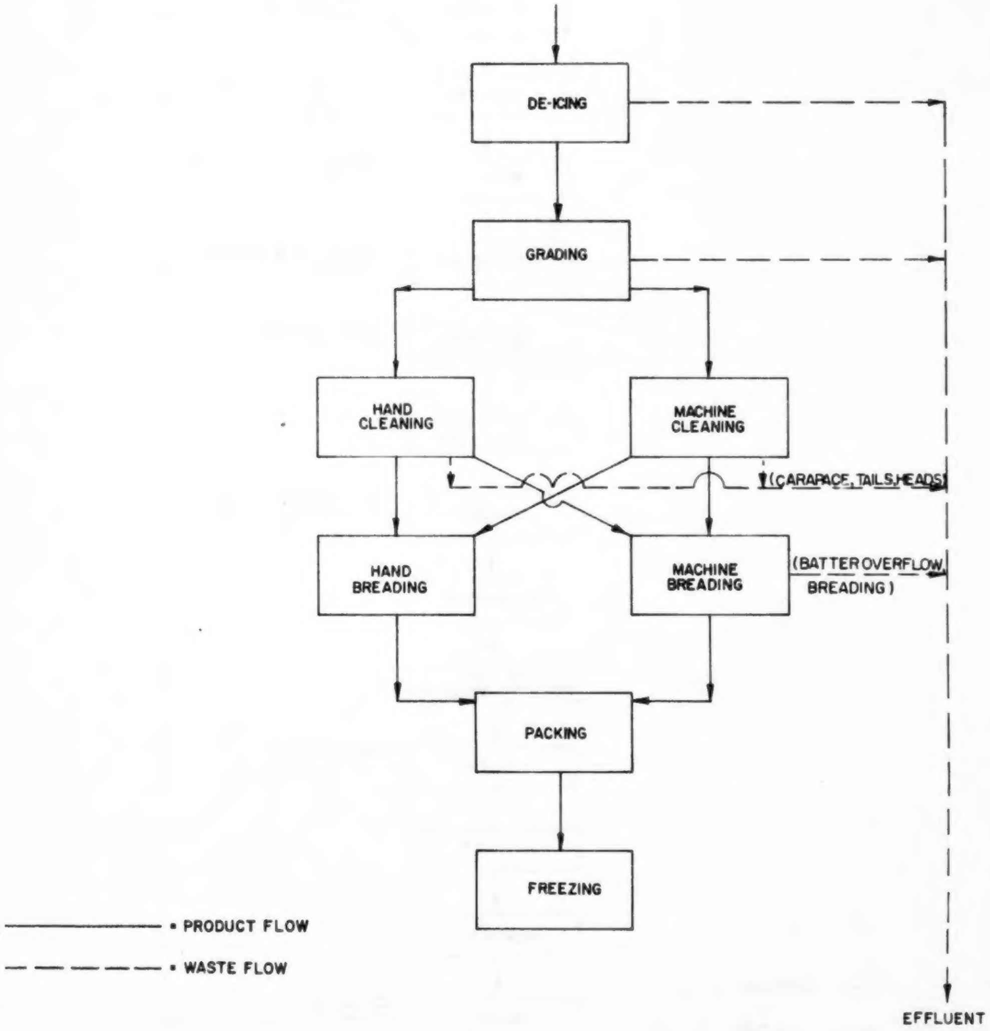
These shrimp are usually received at the breading plant already beheaded, due to the reasons discussed previously for southern shrimp (Section 1.2.2.9)

Figure 10. Flow diagram for a typical southern non-breaded shrimp canning processing plant.


RECEIVING
(FISH & DEBRIS)
PEELERS
(CARAPACE MATERIAL, HEADS & TAILS, WATER)
WASHERS
(WATER)
SEPARATORS
(CARAPACE MATERIAL, WATER)
DEVEINERS (NONCONTINUOUS)
(MEAT, WATER)
INSPECTION CONVEYOR
(DEBRIS)
BLANCHER
(SHRIMP PIECES IN DUMP)
SIZE GRADER
DRY FINAL INSPECTION CONVEYOR
FILLER
(MEAT, WATER)
CLINCHER
SEAMER
RETORT
(HOT WATER)
COOLING TANK
(WATER)
PACKED IN CARTONS
EFFLUENT
= PRODUCT FLOW
= WASTEWATER FLOW
= WASTE SOLIDS FLOW

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

Figure 11. Flow diagram for a typical breaded shrimp processing plant.


DE-ICING
GRADING
HAND CLEANING
MACHINE CLEANING
(CARAPACE, TAILS, HEADS)
HAND BREADING
MACHINE BREADING
(BATTER OVERFLOW, BREADING)
PACKING
FREEZING
PRODUCT FLOW
WASTE FLOW
EFFLUENT

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

and because machine beheading is difficult. Peeling of the shrimp may be either by machine or by hand peeling, which produces shrimp that are more presentable than machine peeled shrimp. Two basic types of peelers are used in this industry, Johnson (PDI) peelers and Seafood Automatic Peelers. These machines can peel from 1,800 to 5,500 kg (4,000 to 12,000 lbs) per day. Breading may be done by machine or manually by experienced persons. If hand-breading is employed, the raw peeled shrimp are dipped in batter and then rolled in bread crumbs until the shrimp are coated. The coated shrimp are then boxed, weighed, sealed, and frozen. The same general process also is employed for mechanical breading. Wastes from the mechanical system originate from holding tanks and from batter mixing tank overflow. Wash water also is generated by rebreading improperly breaded shrimp.

Breaded shrimp are sold as either "fantail" or "butterfly" shrimp. "Fantail" shrimp have the uropodal portion of the tail left and are split partway up the back; "butterfly" shrimp are split whole shrimp with the tail removed. Some plants sell portions of the processed shrimp as whole shrimp, in which case they are frozen, glazed, and packaged in either blast freezers or Individual Quick Frozen (IQF) freezers.

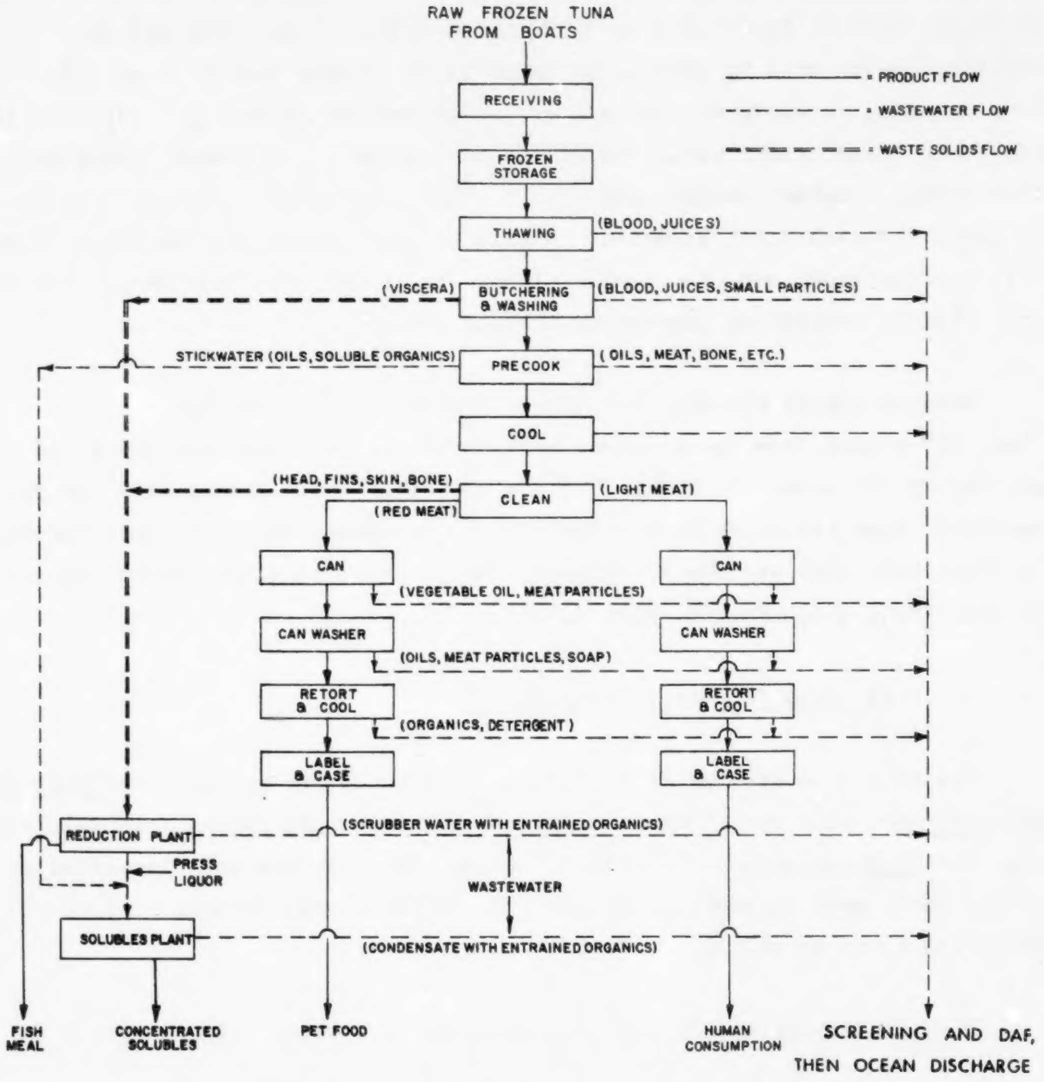
1.2.2.11 Tuna Processing (Figure 12)

The four tuna species of commercial importance are yellow fin (*Neothunus macropterus*), blue fin (*Thunnus thynnus*), skipjack (*Katsuwonus pelamis*), and albacore (*Thunnus germo*). In the industry, these species are classified as either white meat (exclusively albacore), or light meat (processed from the remaining three species).

Tuna processing is divided into nine unit processes (Figure 12):

- Receiving. Tuna are received at the processing plant either fresh (fish harvested locally) or frozen whole in brine (those brought in by high seas tuna clippers). The tuna are unloaded into one ton bins and then transported to the scale house for weighing. At this point, depending on whether the fish is still frozen or production is backlogged, the catch may be processed directly, sent to frozen storage, or sent to refrigerated storage. Fish imported from foreign countries are received and kept frozen until ready for processing.

Figure 12. Flow diagram for a typical tuna processing plant.


RAW FROZEN TUNA FROM BOATS
= PRODUCT FLOW
= WASTEWATER FLOW
= WASTE SOLIDS FLOW
RECEIVING
FROZEN STORAGE
THAWING
(BLOOD, JUICES)
(VISCERA)
BUTCHERING & WASHING
(BLOOD, JUICES, SMALL PARTICLES)
STICKWATER (OILS, SOLUBLE ORGANICS)
PRECOOK
(OILS, MEAT, BONE, ETC.)
COOL
(HEAD, FINS, SKIN, BONE)
CLEAN
(LIGHT MEAT)
(RED MEAT)
CAN
CAN
(VEGETABLE OIL, MEAT PARTICLES)
CAN WASHER
CAN WASHER
(OILS, MEAT PARTICLES, SOAP)
RETORT & COOL
RETORT & COOL
(ORGANICS, DETERGENT)
LABEL & CASE
LABEL & CASE
REDUCTION PLANT
(SCRUBBER WATER WITH ENTRAINED ORGANICS)
PRESS LIQUOR
WASTEWATER
SOLUBLES PLANT
(CONDENSATE WITH ENTRAINED ORGANICS)
FISH MEAL
CONCENTRATED SOLUBLES
PET FOOD
HUMAN CONSUMPTION
SCREENING AND DAF, THEN OCEAN DISCHARGE

Source: U.S. Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segments of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

- Thawing. Fish to be thawed are placed in large thaw tanks which hold 8 to 10 one ton bins. The end plates on the tank are removed and the bins are placed by fork lift. When loaded, the end plates are replaced and the tank flooded. Thawing may be with static or circulating sea and fresh water. Some plants heat the water with steam to speed up the thaw rate.

- Butchering. After thawing, the tanks are drained and the bins of tuna removed with a forklift and placed in an automatic dumper located at the head of the processing line. The tuna are then dumped on a shaker conveyer which spreads them and carries them to a butchering table. Here the body cavities are opened with a saw and eviscerated. These saws are continuously washed with small water jets. The saw cuttings and washings drip onto the floor and then flow into an outer drain under the butcher table. The tuna is then washed and checked organoleptically for freshness. The viscera (10% to 15% of the tuna by weight) are placed in barrels. Putrescent tuna are discarded and sent to the reduction process along with the viscera.

- Precooking. In order to facilitate processing, the tuna are placed in trays set into racks for precooking, a process which loosens the tuna meat from the bone and skin. (The larger tuna are cut in smaller pieces and placed on the trays.) Cookers holding 10 tons of fish are filled with live steam and held at a temperature of 93°C (200°F) for 2 to 4 hours. The stick water (steam condensate, fish oils and liquids) collects in the cookers and is pumped to the solubles plant for by-product manufacture.

- Cleaning. The racks of precooked fish are cooled for about 12 hours in a holding or cooling room. The cooled tuna are removed from the racks and placed on tables that have an elevated stainless steel conveyer running along the packing machine, and at each of the work stations, hoppers which lead to a below table conveyer. The head, fins, skin, tail, and bone are manually removed from the fish and deposited in the hopper; the belt carries the solids (30 to 40% of the tuna by weight) to a collection station where they are taken to a fish meal reduction plant. The red meat (6 to 10% of the tuna) is then scraped from the fish, placed in containers, and sent to the pet food production area. The four loins which remain are put on the upper conveyor belt to the can packing machine.

- Canning. The packing machine shapes the tuna meat and places it in cans. Chunk style tuna is prepared from broken sections and solid pack tuna from the loins. A mixture of soybean oil, salt brine, and monosodium glutamate (MSG) is added to replace lost oils, improve taste, and aid removal from the can. Any overflows from the additive line which occur during packing are collected, filtered, and recirculated. The cans are seamed under vacuum pressure, prerinsed with recirculated water, soap-washed with recirculated waters, and final-rinsed with clear water. An antispotting agent is sometimes added in the final rinse to reduce mineral deposition on the dry cans.

- Retorting. The cans are conveyed to the retorts where they are subjected to a temperature of 121°C (250°F) for 90 minutes to sterilize the product, after which the retort pressure is reduced and the cans cooled with circulating cold water. The cans then are removed for drying and finish cooling.

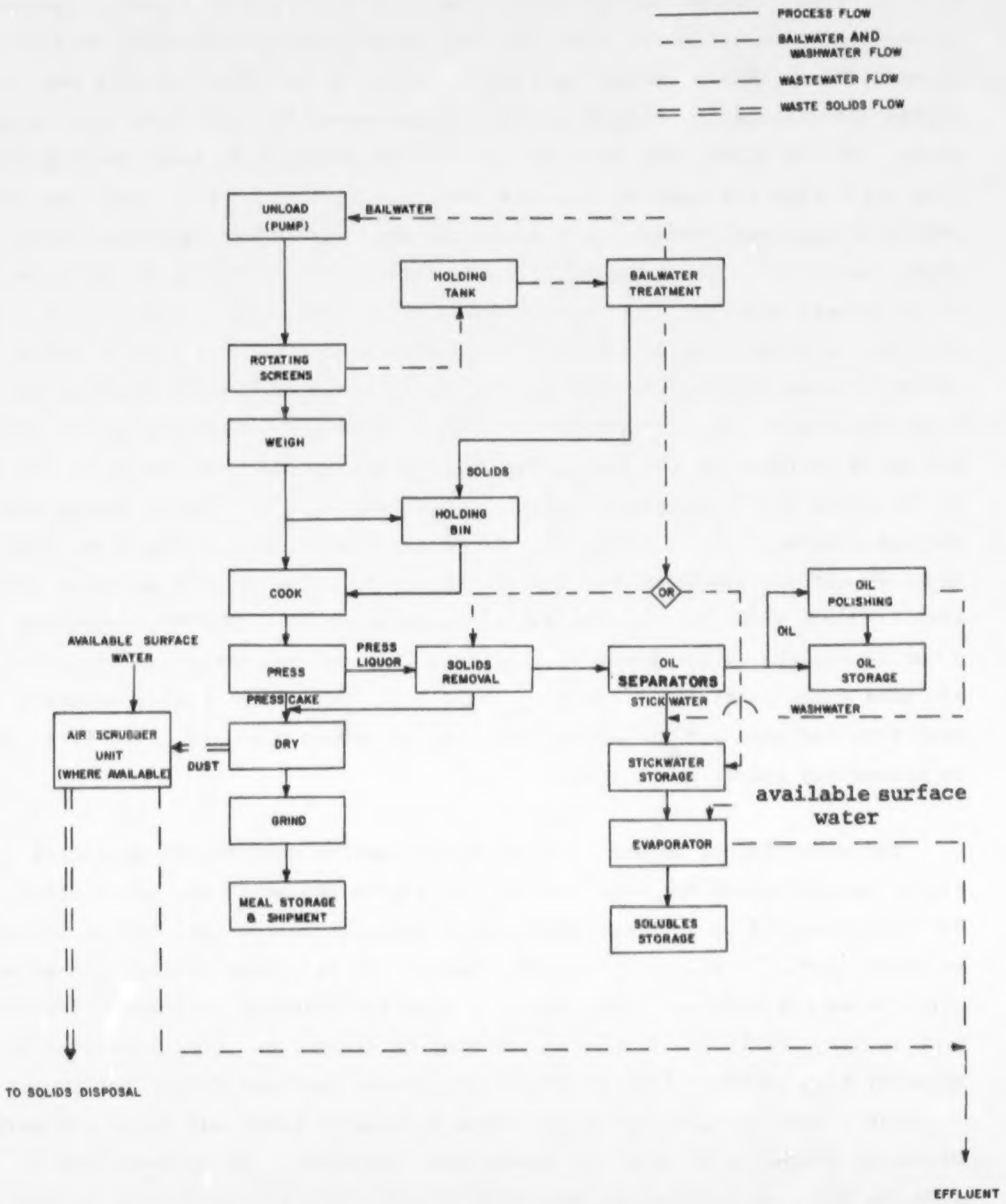
- Labelling and Casing. After cooling, the cans are labeled and boxed. Sterilization of the tuna is necessary to ensure that all organisms in the can are destroyed and especially to prevent botulism caused by the bacteria Clostridium botulinum. All cans are coded at the time of steaming and a representative number of cans from each lot are tested. Each coded lot is sent to a certain market or distributor.

The scraps generated by production of edible canned tuna, screenings from washdown waters, and meat cleaned up before washdown are ground, cooked, and pressed in the reduction area to remove oils and liquids (press liquor). The solids (press cake) are dried, ground, bagged, and marketed as fish meal for use as animal feeds, fertilizer, and many other products. The press liquor, stick water, and sometimes a slurry of ground viscera are then concentrated by heating under vacuum. The oil separated from this liquor is sold as animal feed additives and for other uses. The red meat is sent to a special pet food production area where the cans are mechanically filled, sealed, and rinsed before being conveyed to the retorts. Some plants receive meat and poultry viscera and parts; these are cooked in vats and processed with the red meat in the pet food line.

1.2.2.12 Fish Meal Processing (Figure 13)

This industry segment converts fish to a basic meal product rather than to a commercial food product. Menhaden and anchovy are the two main raw materials used for this purpose. The menhaden is a small fish belonging to the herring family, with two species (Brevoortia tyrannus and Brevoortia patronus) of commercial importance. Ninety-nine percent of the menhaden landed in the United States are used for fish meal, oil, and fish solubles. The meal is used as animal feed, the solubles as liquid fertilizer, and the oils are either exported for use in shortenings and margarine or used domestically in the manufacture of protective coatings, lubricants, medicinals, and some soaps. The northern anchovy (Engraulis mordax) is a small (6 inch) pelagic fish whose body content is high in oil. Previously most anchovies were canned for human consumption or used for bait, but their decline in popularity as a food has promoted development of an anchovy fish-mealing industry on the West Coast.

Figure 13. Flow diagram for a typical large fish meal production processing plant.


PROCESS FLOW
BAILWATER AND WASHWATER FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
UNLOAD (PUMP)
BAILWATER
HOLDING TANK
BAILWATER TREATMENT
ROTATING SCREENS
WEIGH
SOLIDS
HOLDING BIN
COOK
OR
OIL POLISHING
OIL
AVAILABLE SURFACE WATER
PRESS
PRESS LIQUOR
SOLIDS REMOVAL
OIL SEPARATORS
OIL STORAGE
PRESS CAKE
STICK WATER
WASHWATER
AIR SCRUBBER UNIT (WHERE AVAILABLE)
DUST
DRY
STICKWATER STORAGE
available surface water
GRIND
EVAPORATOR
MEAL STORAGE & SHIPMENT
SOLUBLES STORAGE
TO SOLIDS DISPOSAL
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75 041a.

The fish are delivered in large volumes to the plant in the holds of large carrier vessels. The water and fish may be conveyed to shore by pumping with the fish screened out on shore. The bail water can be further screened to remove scales and small particles and recycled back to the ship or discharged. Some plants vacuum the fish directly to the plant, or they may be loaded onto trucks for transport after being washed from the hold with large hoses. At the plant, the fish are weighed and conveyed to large holding bins from which they are augered into the reduction facility. They first are steam cooked in equipment resembling a screw conveyer with steam injection ports along the length. Inlet temperatures in this 9.1 m (30 ft) by 60 to 76 cm (25 to 30 inches) diameter cooker are 110°C (230°F), and outlet temperatures 116°C (240°F). Cooking time is about 10 to 15 minutes and is critical: if overcooked or undercooked, there is excess oil in the meal causing poor oil recovery. From the cookers the fish are run through a screw press to separate the liquid and solid portions of the fish. The fish solids (press cake) pass out the end of the press with a moisture content of 55% and the press liquor passes out through a screen. Most plants dry the press cake using rotating drums that have hot air and vapors drawn through the driers. The hot air entrance temperature is 540°C (1000°F) with the outlet temperature 93°C (250°F), requiring about 15 minutes to dry the meal. Because the tumbling action of the drier entrains small particles of meal in the air, a cyclone is used to separate the meal from the air, and the air is scrubbed to remove organics. The dried meal is ground and stored for shipment.

The press liquor is put through screens and/or centrifugal decanters to remove solids, which are sent back to the drying process. The press liquor is further processed by a three-stage centrifuge, the centrifuged oil is washed in water, and a final centrifugation removes any remaining protein and solubles which cause putrefaction. The oil is stored for shipment with the stickwater sent to large tanks for further processing or discharge. The stickwater is adjusted with sulfuric acid to pH 4.5 to prevent spoilage during holding or shipping. Small plants unable to afford a solubles plant may barge stickwater to sea or discharge it into the waters near the plant. If solubles are to be marketed for tuna processing (see Section 1.2.2.11), the stickwater is treated the same as for tuna processing.

1.2.2.13 Salmon Processing: Alaskan and West Coast Hand-butchered and Mechanized-butchered (Figures 14, 15, and 16)*

Salmon may be harvested by trollers, purse seining, or gill nets. Trollers generally fish for king and silver salmon throughout the year in parts of Alaska, but the majority of the salmon are caught and processed between June and September when large schools return to their native streams for spawning. These troll-caught salmon generally are eviscerated and packed on ice immediately after being caught to reduce autolysis. Because of this, the product quality for troll-caught salmon is better than for purse-seined or gill netted fish which are held on board the vessel longer in an uncleaned state. Net caught fish also are subject to crushing and net cutting during harvesting. Salmon usually are hand-sorted and weighed as they are sold either to a processor's tender boat or directly to the plant. A pump and bail water system may be used at the plant to remove salmon from the tender, with the fish sorted and weighed before being iced or placed in chilled brine until processing. Troll-caught salmon may be sent to market as fresh fish, after being washed and sometimes after freezing.

For mechanical processing, the fish are removed from the holding bins by elevator or flume and placed on a rotating ring in the mechanical cleaning machine which, in a single cycle, positions and measures the fish; cuts off the head; and clamps the fish into a large upright ring-shaped machine. This machine then opens the belly; cuts off the back and belly fins; eviscerates the fish; removes the kidneys; brushes the body cavity; and places the fish on a production conveyer. These machines are capable of cleaning up to 120 fish per minute. Sometimes a scrubber is used to clean the body cavity of the fish

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[*] Salmon processing is now limited to the Pacific Coast states, with the loss of the Atlantic salmon fishery. The four subcategories of salmon processing (Alaskan hand butchered, Alaskan mechanized, West Coast hand-butchered, and West Coast mechanized) are grouped together for the discussion of their production methods.

more thoroughly. Roe and milt from the salmon are manually separated and taken to a separate area for processing. Some plants collect the red salmon heads for rendering into oil. Figure 14 includes a flow diagram for by-product processes.

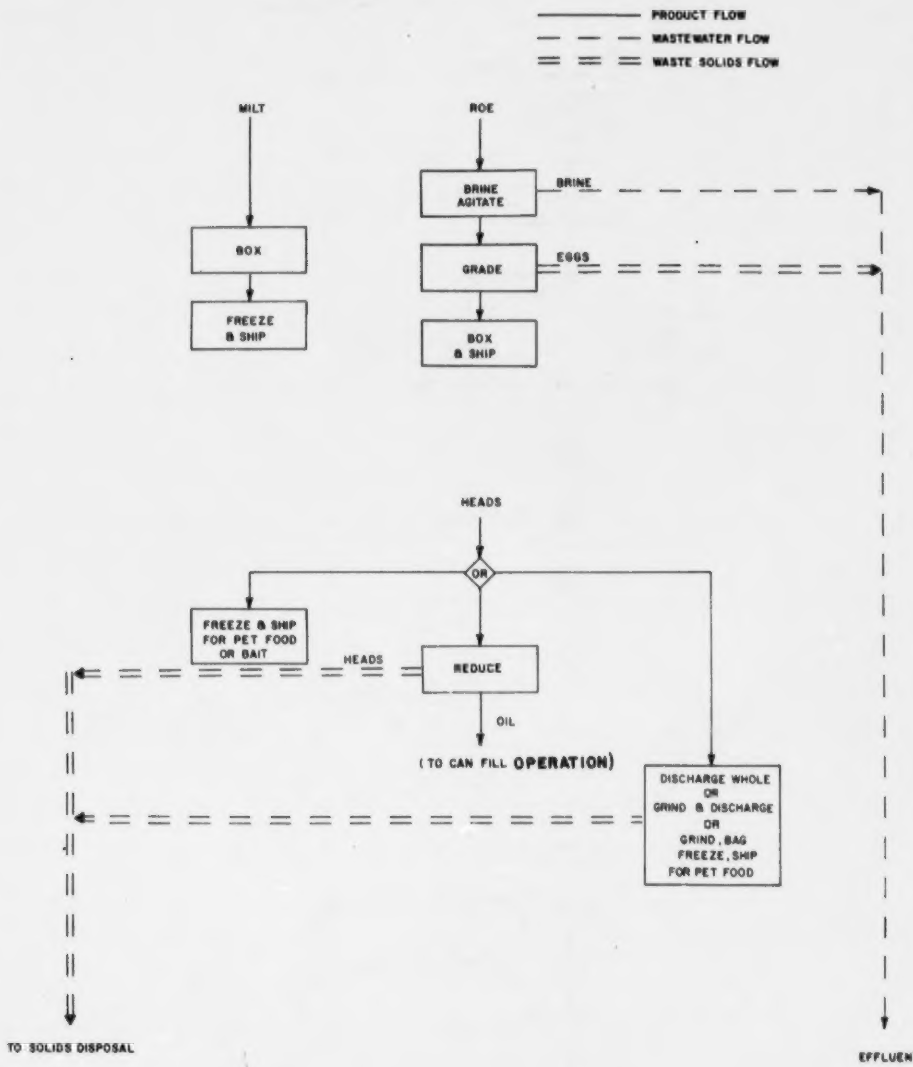
In those plants which hand-butcher, the salmon are eviscerated, the kidneys are removed, the fish are slimed (washed), and the heads and fins are removed. The roe and milt are separated at the evisceration station for further processing.

Canning is the next step after both hand and mechanical butchering. In small plants, hand packing may be used to fill cans: the salmon are simply cut into chunks and placed in the cans until the proper can weight is reached. In the case of mechanical packing, the fish pass into a filler machine which cuts up the fish and packs it into cans. As the filled cans move down the line they are weighed and sent to be "patched" if necessary (hand filled to the proper weight using small pieces of salmon). Workers also remove any bones or meat which may interfere with the seaming machine. After being seamed under vacuum, the cans are washed, placed in trays, and retorted at 120°C (250°F) (four pound cans retorted for four hours; one pound cans for ninety minutes; and one quarter pound cans for forty minutes). The processed cans are water-cooled by flooding the retort, immersion in a water bath, or a cold water spray. The cans are further air cooled and dried before being cased. Figure 15 presents the flow diagram for these processes.

Salmon for the fresh or frozen market generally are hand-butchered or semiautomatic beheaders are used. The process is the same as for the canning method except that the fish are frozen after being slimed. Sometimes the fish are frozen "in the round" (i.e., without processing or in the same conditions as when caught), in which case the fish are washed, frozen at -51°C (-60°F), glazed, packaged, and stored at -23°C (-10°F). Salmon from the Pacific Northwest are sold fresh in much larger numbers than Alaskan salmon. (See Figure 16 for the fresh or frozen salmon process.)

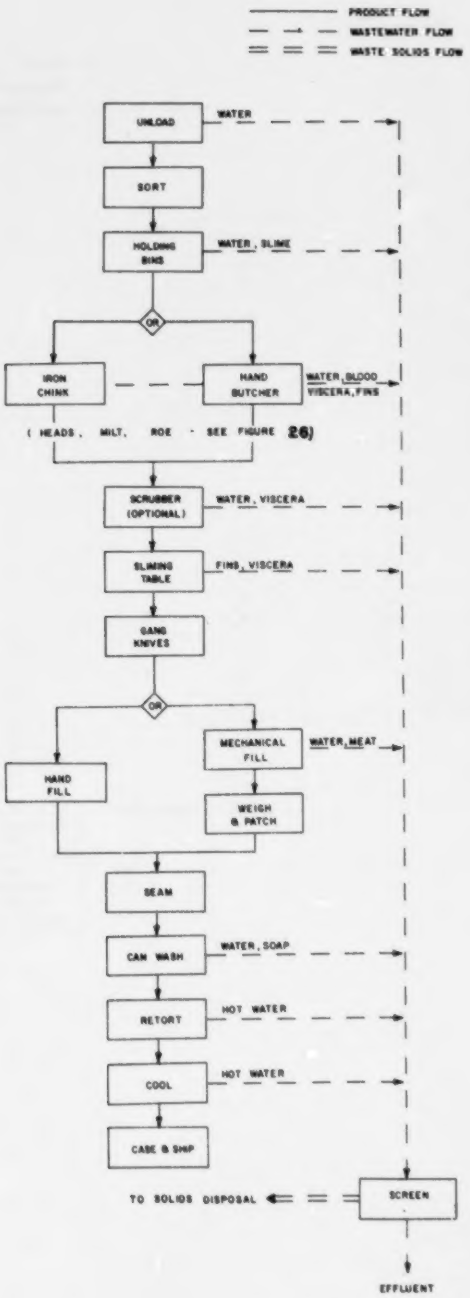
Excess salmon occasionally are cured in brine, in which case the salmon are cut from the back to the belly flap and opened (Halifax cut). The bones

Figure 14. Flow diagram for a typical salmon by-product processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
MILT
BOX
FREEZE & SHIP
ROE
BRINE AGITATE
BRINE
GRADE
EGGS
BOX & SHIP
HEADS
OR
FREEZE & SHIP FOR PET FOOD OR BAIT
HEADS
REDUCE
OIL
(TO CAN FILL OPERATION)
DISCHARGE WHOLE OR GRIND & DISCHARGE OR GRIND, BAG FREEZE, SHIP FOR PET FOOD
TO SOLIDS DISPOSAL
EFFLUENT

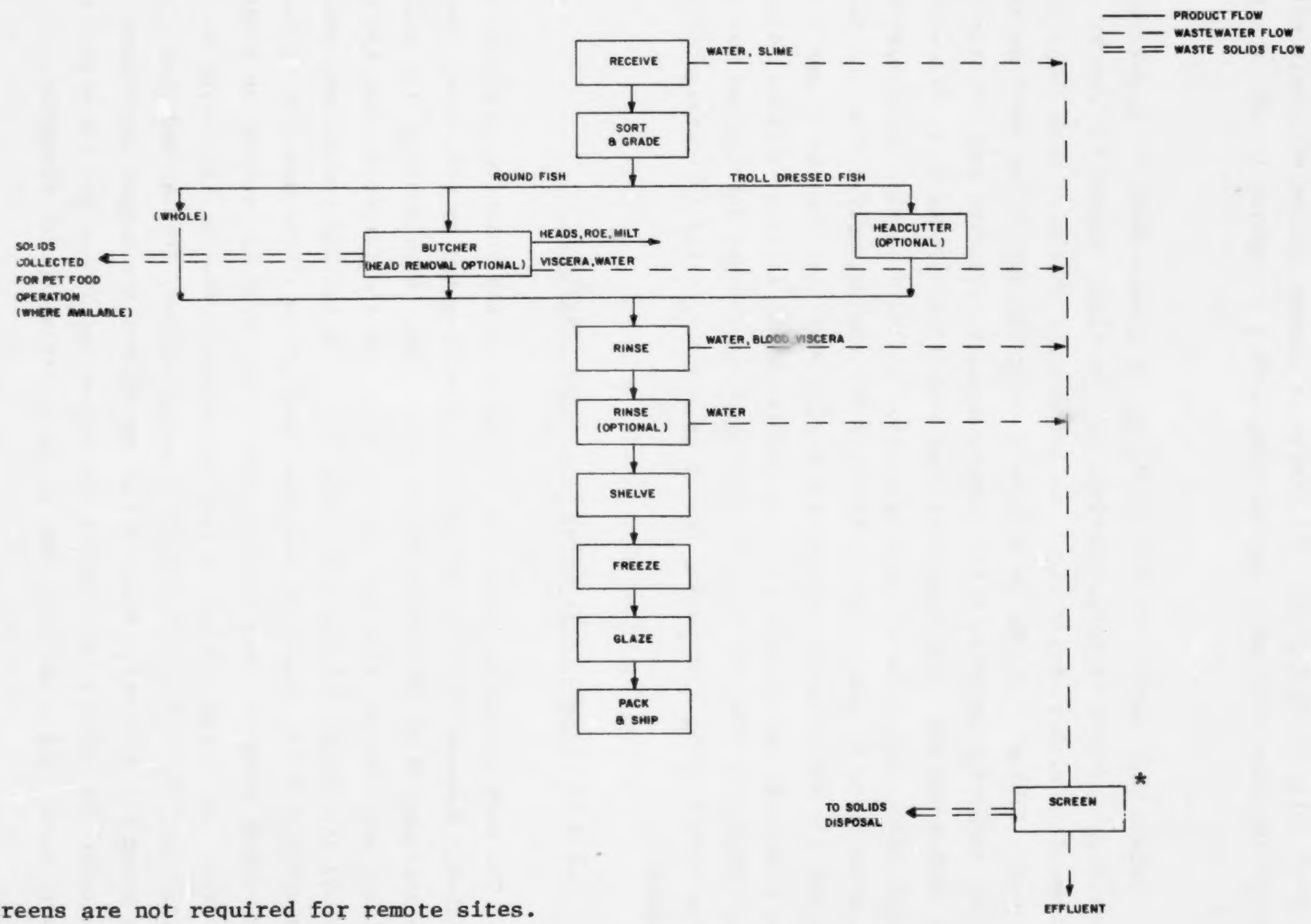
Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

Figure 15. Flow diagram for a typical salmon canning processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
UNLOAD
WATER
SORT
HOLDING BINS
WATER, SLIME
OR
IRON CHINK
HAND BUTCHER
WATER, BLOOD
VISCERA, FINS
(HEADS, MILT, ROE - SEE FIGURE 26)
SCRUBBER (OPTIONAL)
WATER, VISCERA
SLIMING TABLE
FINS, VISCERA
GANG KNIVES
OR
MECHANICAL FILL
WATER, MEAT
HAND FILL
WEIGH & PATCH
SEAM
CAN WASH
WATER, SOAP
RETORT
HOT WATER
COOL
HOT WATER
CASE & SHIP
TO SOLIDS DISPOSAL
SCREEN
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

Figure 16. Flow diagram for a typical fresh/frozen salmon processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
RECEIVE
WATER, SLIME
SORT & GRADE
ROUND FISH
TROLL DRESSED FISH
(WHOLE)
BUTCHER (HEAD REMOVAL OPTIONAL)
HEADS, ROE, MILT
VISCERA, WATER
HEADCUTTER (OPTIONAL)
SOLIDS COLLECTED FOR PET FOOD OPERATION (WHERE AVAILABLE)
RINSE
WATER, BLOOD, VISCERA
RINSE (OPTIONAL)
WATER
SHELVE
FREEZE
GLAZE
PACK & SHIP
SCREEN
*
TO SOLIDS DISPOSAL
EFFLUENT

* Screens are not required for remote sites.

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

are removed and alternate layers of fish and salt are placed in a tierce (barrel) until it is filled. The tierce is closed, filled with salt solution through the side bung hole, and the bung driven in tightly to make the final seal.

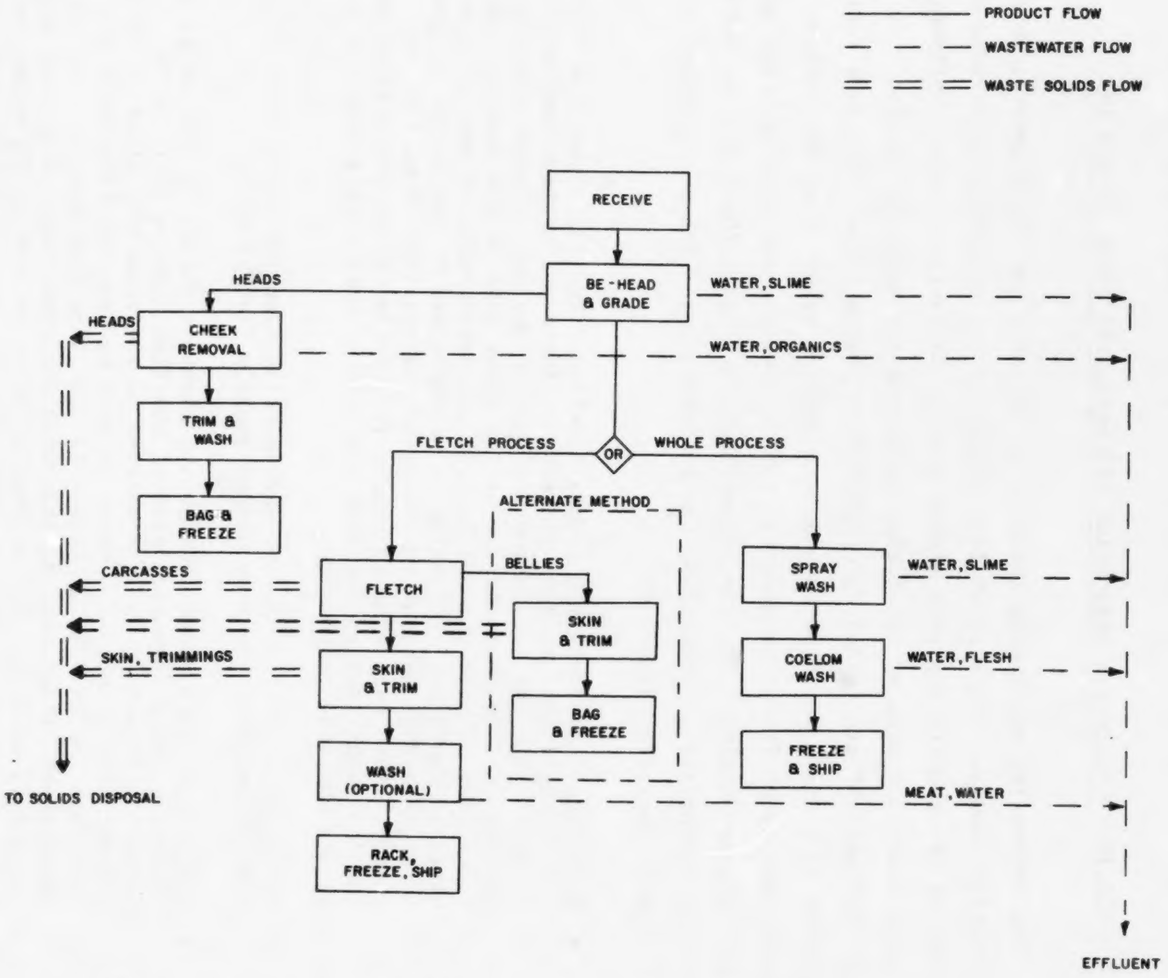
Salmon milt usually is discarded, but in plants where it is sold the processing involves washing, packing, and freezing. Salmon roe may be processed in either of two ways: as cured whole skeins of eggs (sujiko), or as caviar (ikura). Sujiko is made by washing the egg skeins and then agitating them in a brine solution containing salt, ascorbic acid, citric acid, and sodium nitrite. The sujiko is then air-dried, placed in plastic-lined wooden boxes, and cured at room temperature. Ikura is made by washing skeins of mature eggs in clear water. The eggs are then separated from the skeins by rolling the skeins over a nylon rack strung very similarly to a tennis racket. The loose eggs are drained on racks before being placed in a brine solution very similar to that for sujiko. The eggs are removed and drained for several hours before being bulk-packed in six gallon poly pails for refrigeration and transport.

1.2.2.14 Alaskan Bottomfish Processing (Figure 17)

The only bottomfish presently harvested in any quantity in Alaska is halibut. Because halibut fishing trips last from two to four weeks, the fish are eviscerated at sea and stored in iced holds. Upon docking, the small halibut are unloaded from the ship in totes and the larger halibut (50 to 250+ pounds) are lifted off board with winches. The halibut are washed, graded, and weighed at the receiving station. Small fish (those under 27 kg (60 lbs) are washed, beheaded, and frozen whole, then glazed and stacked in holding freezers for shipment. Larger fish are beheaded and cut into large sections called fletches. The fletches are trimmed, washed, frozen, and then glazed and boxed for shipment. Small pieces of halibut are bagged and frozen. The cheeks of the halibut are removed and bagged and frozen for the retail market. Heads, bones, skin, and fins removed during trimming are discarded.

The bottomfish processing plants being planned and built in Alaska will be highly automated and will be designed to handle bottom fish other than

Figure 17. Flow diagram for a typical Alaskan or northwest halibut processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
RECEIVE
BE-HEAD & GRADE
WATER, SLIME
HEADS
HEADS
CHEEK REMOVAL
WATER, ORGANICS
TRIM & WASH
BAG & FREEZE
FLETCH PROCESS
OR
WHOLE PROCESS
ALTERNATE METHOD
BELLIES
CARCASSES
FLETCH
SKIN & TRIM
SKIN, TRIMMINGS
SKIN & TRIM
BAG & FREEZE
SPRAY WASH
WATER, SLIME
COELOM WASH
WATER, FLESH
FREEZE & SHIP
WASH (OPTIONAL)
MEAT, WATER
TO SOLIDS DISPOSAL
RACK, FREEZE, SHIP
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

halibut (E.C. Jordan 1979). The unit processes for these plants are more likely to be similar to the non-Alaskan bottom fish processes (Section 1.2.2.15).

1.2.2.15 Non-Alaskan Bottomfish Processing (Figures 18 and 19)

The bottomfish processing industry is spread along the Atlantic, Gulf, and Pacific coasts. The type of fish processed may be different between each section of the country and even within ports. In fact, the name "bottomfish" is a misnomer, for some of the fishes processed are midwater species. In some areas "bottomfish" are called "groundfish" or "white fish." The same fish may be called by a different name in adjacent regions or one name may include several species of fish. In general, bottom-dwelling and midwater fish such as flounder are included in this classification. While there will be variations due to the fishes processed, the following major processing steps occur at a typical facility (Figure 18).

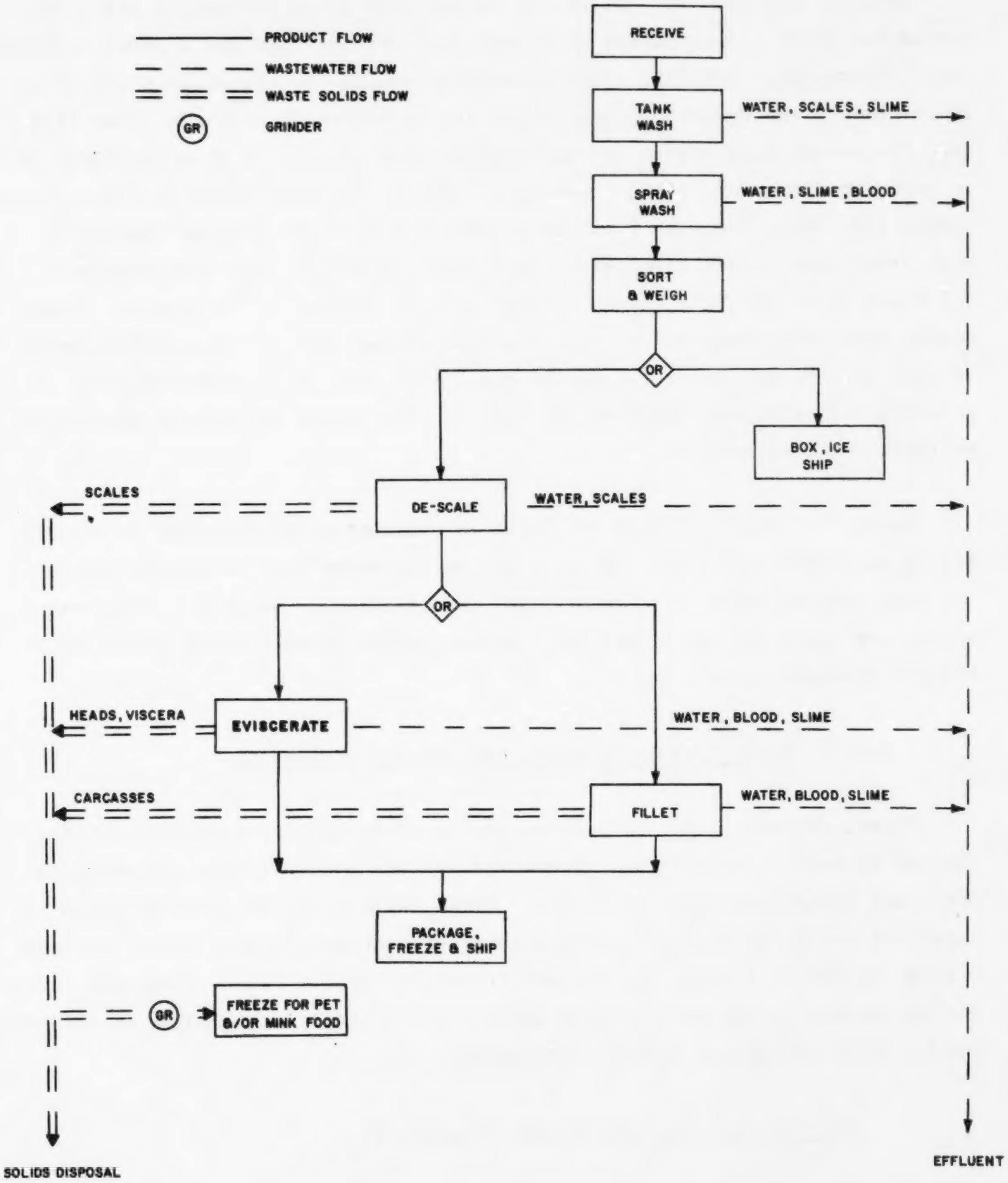
- Receiving. As in salmon plants (Section 1.2.2.13), there are hand processing lines, machine processing lines, and various combinations of each. The smaller bottomfish such as whiting, flounder, perch, pollock, and sea bass arrive at the plant iced in the round, while large fish such as cod and haddock are eviscerated at sea and iced to minimize spoilage. Unloading is accomplished by vacuum lines, pumps, or by hand depending on the location and species. Some fish are washed before receiving to remove ice, while others are weighed and the ice weight subtracted from the catch. Most plants hold the fish on ice awaiting processing.

- Descaling. The fish may be mechanically descaled using water jets or tumble descalers but many plants descale fish by hand.

- Filleting. In a manual butchering plant, a fillet is removed at the filleting table from each side of the fish using a sharp knife. The remaining fish is usually discarded to the rendering plant or to a grinder and discharged. Water is used to keep the fish solid and to clean the tables. If machinery is used, the fish are fed into one end and skinned fillets are ejected from the other end. The skins and scrap fall into bags for disposal. Water is used in filleting machines to keep the knives clean and for wash up. Hand filleting plants use either knives or a semi-automatic skinner which removes the skins by abrasion. The skins are flushed out of the machine and the fillets pass into a chilled brine for preservation.

- Packaging and Freezing. The fillets are removed by hand or elevator to the packing and freezing stations. Some fillets are breaded before freezing; this process is very similar to that described for shrimp breading (See Section 1.2.2.10). Fish to be sold as frozen whole fish

Figure 18. Flow diagram for a typical bottomfish processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
GR
GRINDER
RECEIVE
TANK WASH
WATER, SCALES, SLIME
SPRAY WASH
WATER, SLIME, BLOOD
SORT & WEIGH
OR
BOX, ICE SHIP
SCALES
DE-SCALE
WATER, SCALES
OR
HEADS, VISCERA
EVISCERATE
WATER, BLOOD, SLIME
CARCASSES
FILLET
WATER, BLOOD, SLIME
PACKAGE, FREEZE & SHIP
GR
FREEZE FOR PET &/OR MINK FOOD
SOLIDS DISPOSAL
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

are eviscerated, beheaded (in some plants), washed, and packed into trays. The pans are flooded with water and frozen before boxing. Some species are boxed and then frozen.

Another technique for bottomfish is the fish flesh process, a relatively new method which allows better utilization of smaller fish and a lower operating cost (Figure 19). The fish flesh process is similar to the process described above through the descaling, beheading, and eviscerating stations. The fish then are passed onto a belt and are pressed over a plate or drum traveling in an opposite direction. This pressing separates the flesh from the skin, bones, and fins. The fish flesh is collected and inspected, and then mixed with other ingredients to enhance taste and to bind the particles together. The flesh is formed into blocks by extrusion or forms, and is frozen. These blocks are sawed into smaller slabs for fillets or fish steaks. Little water is used in this operation and solids are either sent to a rendering plant or ground and discharged. Most solids from the bottomfish processing plants are suitable for fish meal.

Among the other processes utilized in the bottomfish industry is the drying and salting of cod. Cod also may be processed into lutefisk, dried, and then reconstituted in a sodium carborate solution. Generally these other plants are small and serve an ethnic market, although salted and dried cod is shipped throughout the world.

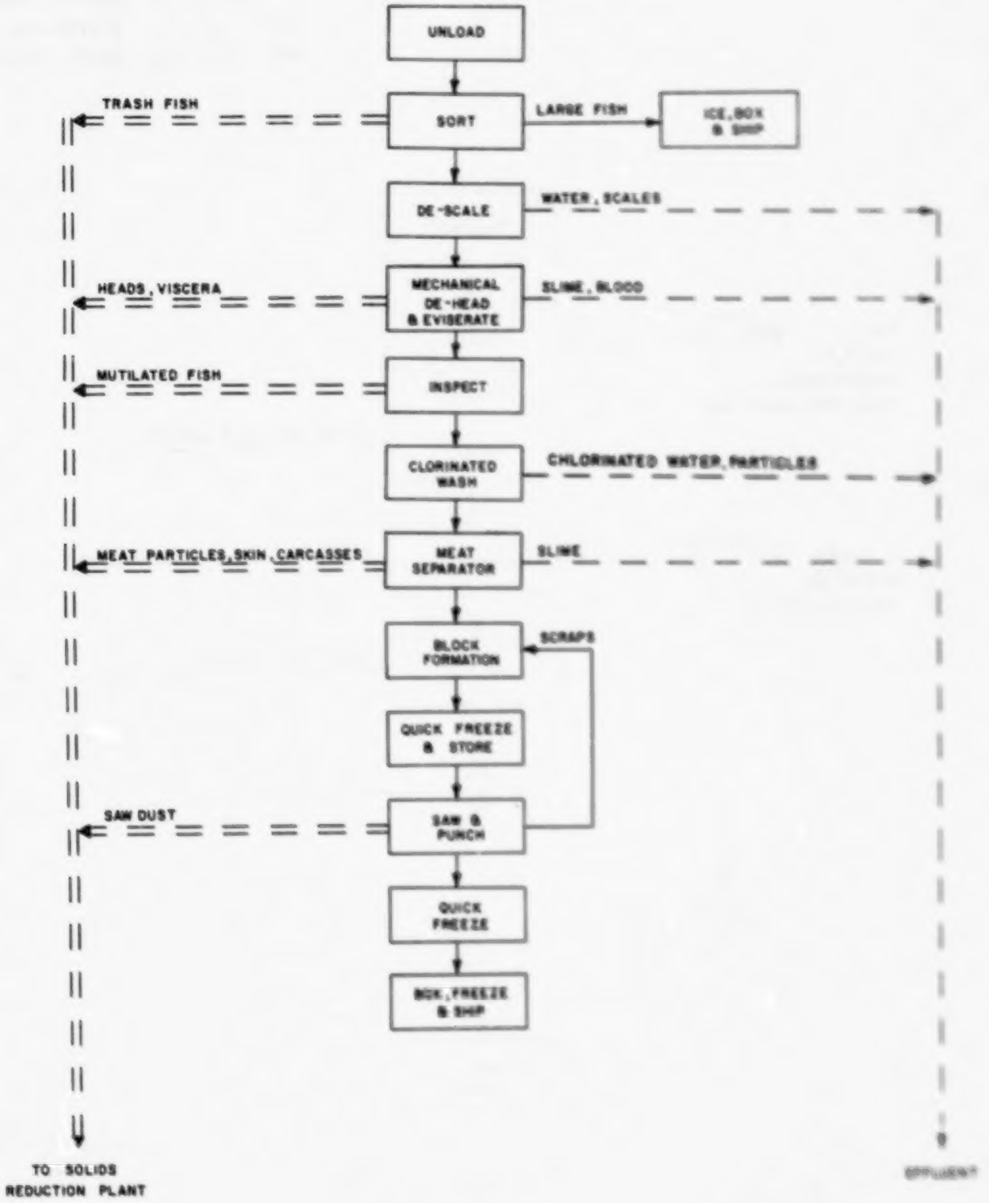
1.2.2.16 Clam, Oyster, Scallop, and Abalone Processing

Clams, oysters, and scallops are processed by similar techniques whether shucked by hand or by machine. Clams and oysters generally are processed as fresh and frozen seafoods for market. Fresh whole clams and oysters go to the retail or restaurant markets. The shucked product may be sold fresh, although a large volume is frozen, breaded and frozen, or canned. Surf clams and ocean quahogs generally are mechanically shucked while larger percentages of soft-shell and hardshell clams are manually processed.

Hand-Shucked Clam Processing (Figure 20)

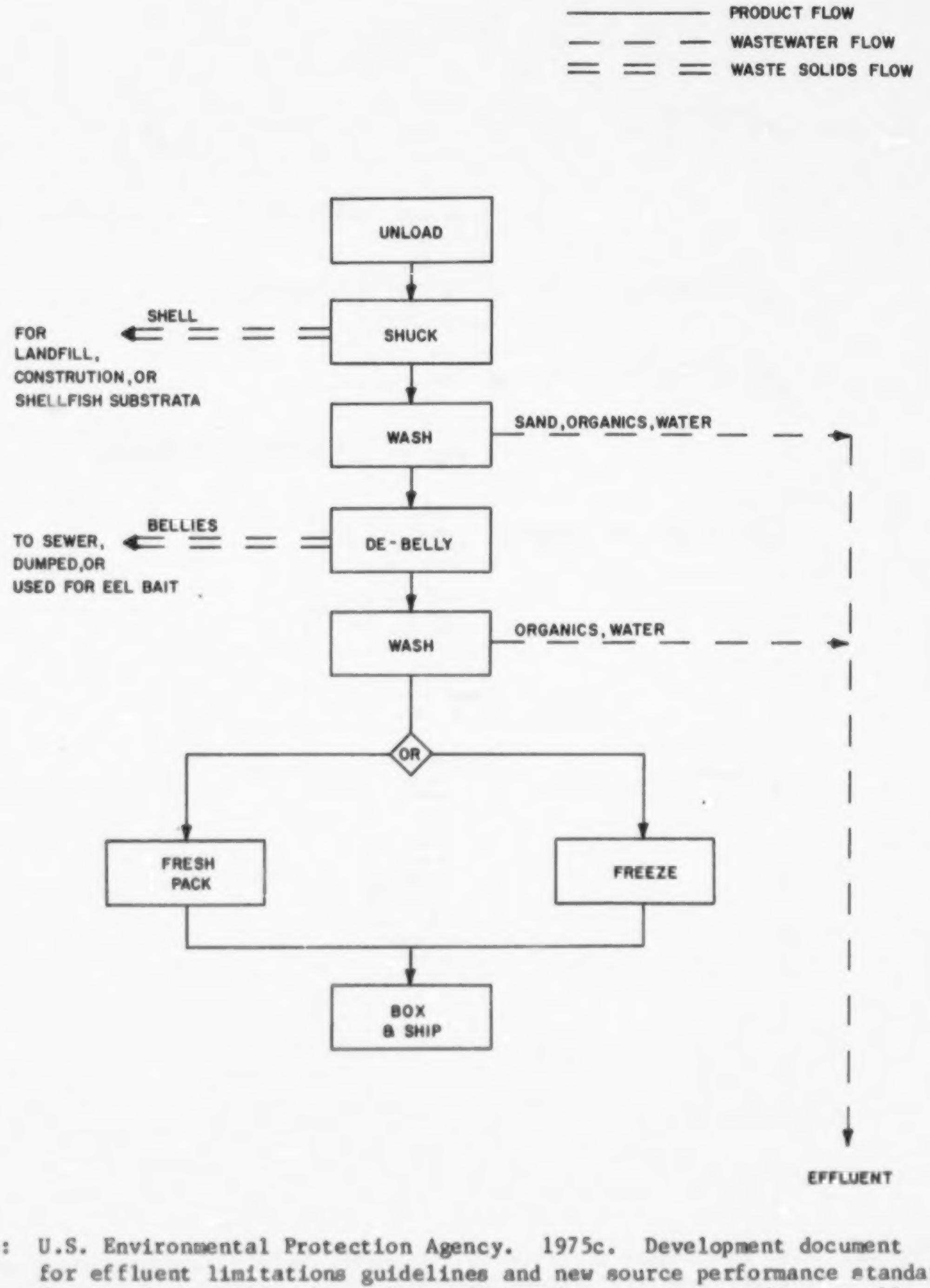
Clams are unloaded from the vessels in large wire baskets, conveyed into the processing plant, and washed. Hand-shucking is accomplished by using a

Figure 19. Flow diagram for a typical fish flesh processing plant.


UNLOAD
TRASH FISH
SORT
LARGE FISH
ICE, BOX & SHIP
DE-SCALE
WATER, SCALES
HEADS, VISCERA
MECHANICAL DE-HEAD & EVISCERATE
SLIME, BLOOD
MUTILATED FISH
INSPECT
CLORINATED WASH
CHLORINATED WATER, PARTICLES
MEAT PARTICLES, SKIN, CARCASSES
MEAT SEPARATOR
SLIME
BLOCK FORMATION
SCRAPS
QUICK FREEZE & STORE
SAW DUST
SAW & PUNCH
QUICK FREEZE
BOX, FREEZE & SHIP
TO SOLIDS REDUCTION PLANT
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

Figure 20. Flow diagram for a typical hand-shucked surf clam processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
UNLOAD
SHUCK
SHELL
FOR LANDFILL, CONSTRUTION, OR SHELLFISH SUBSTRATA
WASH
SAND, ORGANICS, WATER
DE-BELLY
BELLIES
TO SEWER, DUMPED, OR USED FOR EEL BAIT
WASH
ORGANICS, WATER
OR
FRESH PACK
FREEZE
BOX & SHIP
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

special knife which is inserted through the shell and severs the adductor muscle. The meat is then removed from the shell. The shell is used for oyster bed substrate, construction fill material, animal food supplement, or sent to a landfill. The clam meat is butchered to remove the belly, washed for freezing or fresh packing, and boxed for shipment. Clam bellies are either used for bait or discarded.

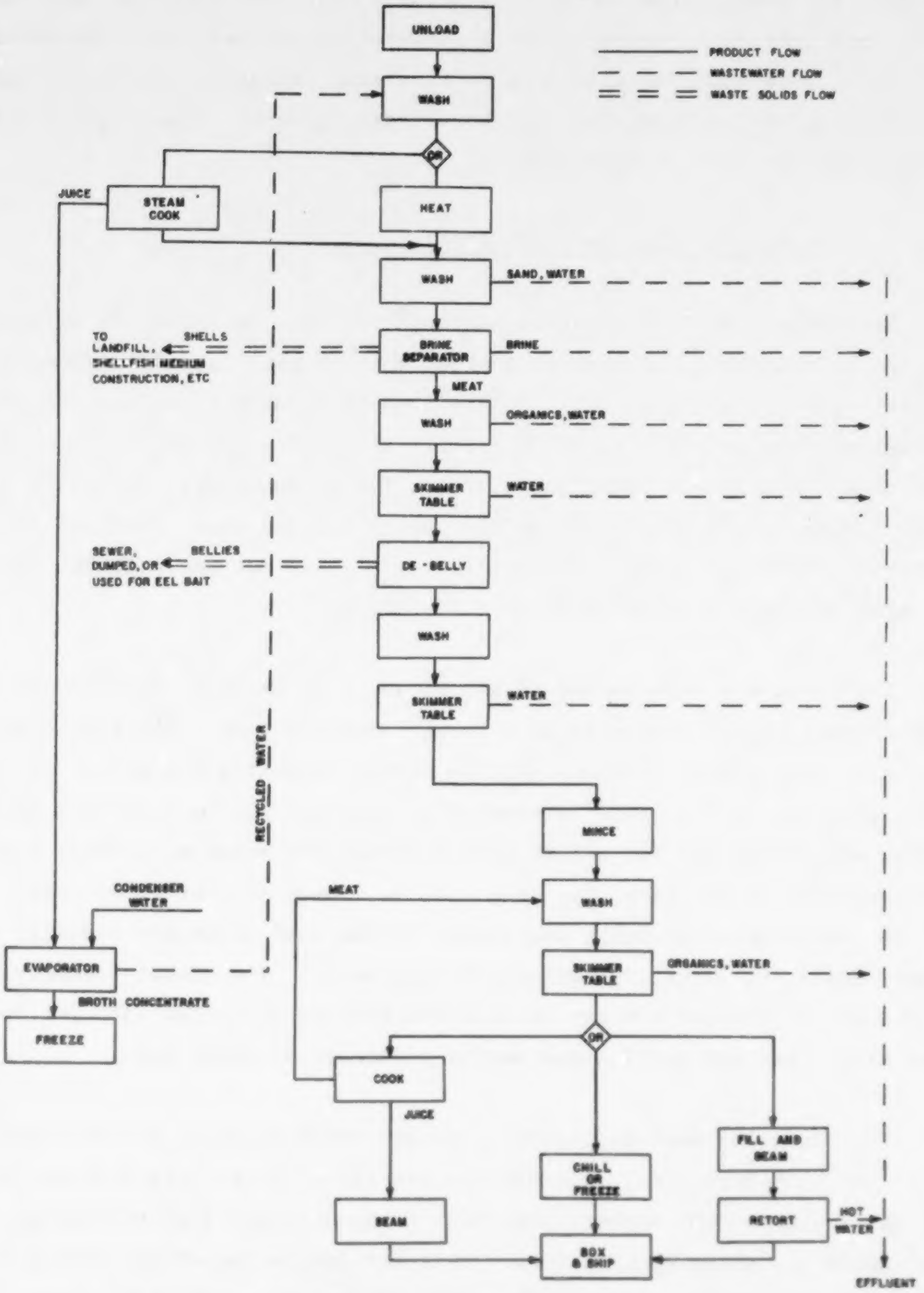
Mechanized Clam Processing (Figure 21)

Mechanical shucking involves heating the clams to cause the adductor muscles to release. The heat is applied by a propane-fueled furnace, a steam cooker, or a hot water cooker. In the propane furnace the clams are exposed to temperatures of 625°C to 815°C (1160°F to 1500°F) for 50 to 100 seconds as they pass through on a metal chain belt. The steam cooker treats the clams with 15 psig, 132°C (210°F) steam for one or two minutes. Residual liquid matter (clam broth) passes to a concentrator. The hot water cooker exposes the clam for one to two minutes at 82°C (180°F).

The clams are then washed in one or two reel washers, followed by separation of shell stock from meat in a brine flotation tank. The shells may be shaken or run through a hammer mill to aid in releasing the meat. Any meat still adhering to the shell is removed by hand and placed in a reel washer. Shells are stockpiled for use as road construction materials, shell fish spawn substrate, or landfilled. The clam meat is flumed or sent by conveyor to the table where the belly and gonads of the surf clams are manually removed. (Some plants are installing automated equipment.) The viscera usually are ground and discharged but may be sold for bait or processed into pet food. Some hard clams and small clams may be processed as whole meat.

The remaining meat is sent to a washer which agitates the meat and removes any entrained sand. Washers may use air or water jets for agitation or may use a simple reel washer. The meat is then passed from the washer over a perforated stainless steel skimmer table for dewatering which readies the clams for further processing. The clams may be whole, chopped, diced, or minced before being canned or frozen. Some plants condense the broth from the first cookers and can it separately (clam nectar) or with the clam meat. The

Figure 21. Flow diagram for a typical mechanized surf clam processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
UNLOAD
WASH
OR
JUICE
STEAM COOK
HEAT
WASH
SAND, WATER
TO LANDFILL, SHELLFISH MEDIUM CONSTRUCTION, ETC
SHELLS
BRINE SEPARATOR
BRINE
MEAT
WASH
ORGANICS, WATER
SKIMMER TABLE
WATER
SEWER, DUMPED, OR USED FOR EEL BAIT
BELLIES
DE-BELLY
WASH
SKIMMER TABLE
WATER
RECYCLED WATER
MINCE
MEAT
WASH
CONDENSER WATER
EVAPORATOR
SKIMMER TABLE
ORGANICS, WATER
BROTH CONCENTRATE
FREEZE
OR
COOK
JUICE
FILL AND SEAM
CHILL OR FREEZE
SEAM
RETORT
HOT WATER
BOX & SHIP
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

canned clams or nectar is retorted after the can filling and seaming stations. Frozen clams are boxed and frozen before shipment.

Hand Shucked Oyster Processing: Gulf Coast, East Coast, and West Coast (Figure 22)

Oyster processing is generally less complex than clam processing, because the viscera of the oyster are not removed. Hand shucking of oysters is accomplished in the same manner as for clams. The shucked meats are graded and washed on a skimmer table before the oysters are blow-washed. Shells go to the shell pile to be used for shell stock, construction, or animal feed additives. Oysters are blow-washed to remove sand and plump the meat (add water). The oysters are again dewatered on a skimmer table and sent to the packing area. There they may be packed in containers and iced for the fresh market, or breaded and frozen. Some plants take broken oyster pieces and make them into oyster stew which is then canned and retorted or canned and frozen.

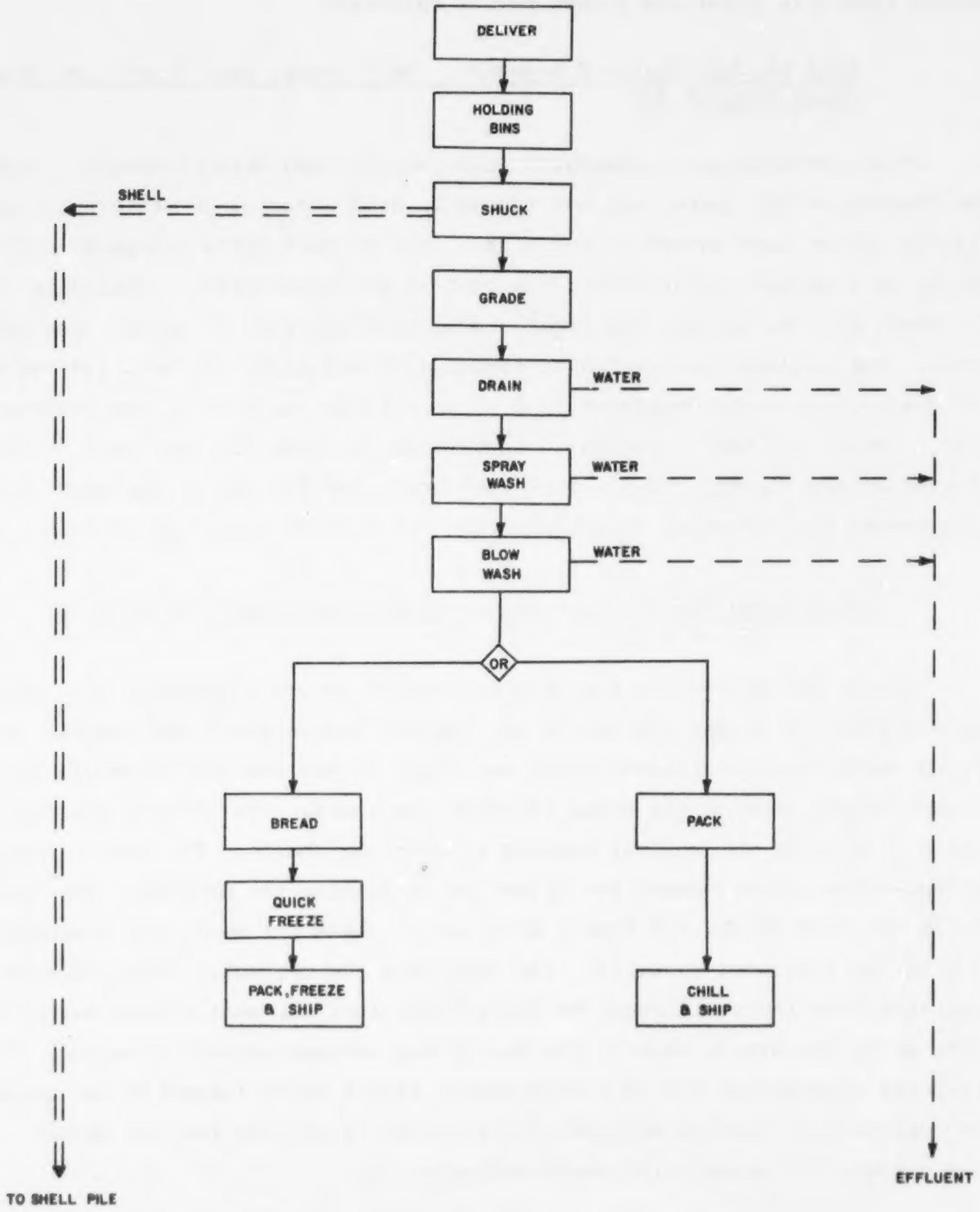
Mechanized Oyster Processing: Steamed and Canned (Figure 23)

Oysters for mechanical shucking are washed in two sequential drum washers. The first washer cleans the shells and removes broken shell and seaweed; the second washer has a different pitch and tends to jar the shells enough to allow a slight opening for steam to enter the shell. The oysters are then placed in retorts for several minutes to open the shells. The oyster liquids are collected and condensed for later use in canning the product. The opened shells are then either fed into a drum washer where the meats are separated or they may be separated manually. The meat from the mechanical operation is separated from the shell stock by brine flotation; the meat floats out of the tank, while the shells sink to the bottom and are mechanically removed. The meats are blow-washed and then drum-washed before being inspected and canned. The oysters are fresh packed and either frozen or chilled for the market. Some oysters are canned with broth and retorted.

Scallop Processing: Alaskan and Non-Alaskan (Figure 24)

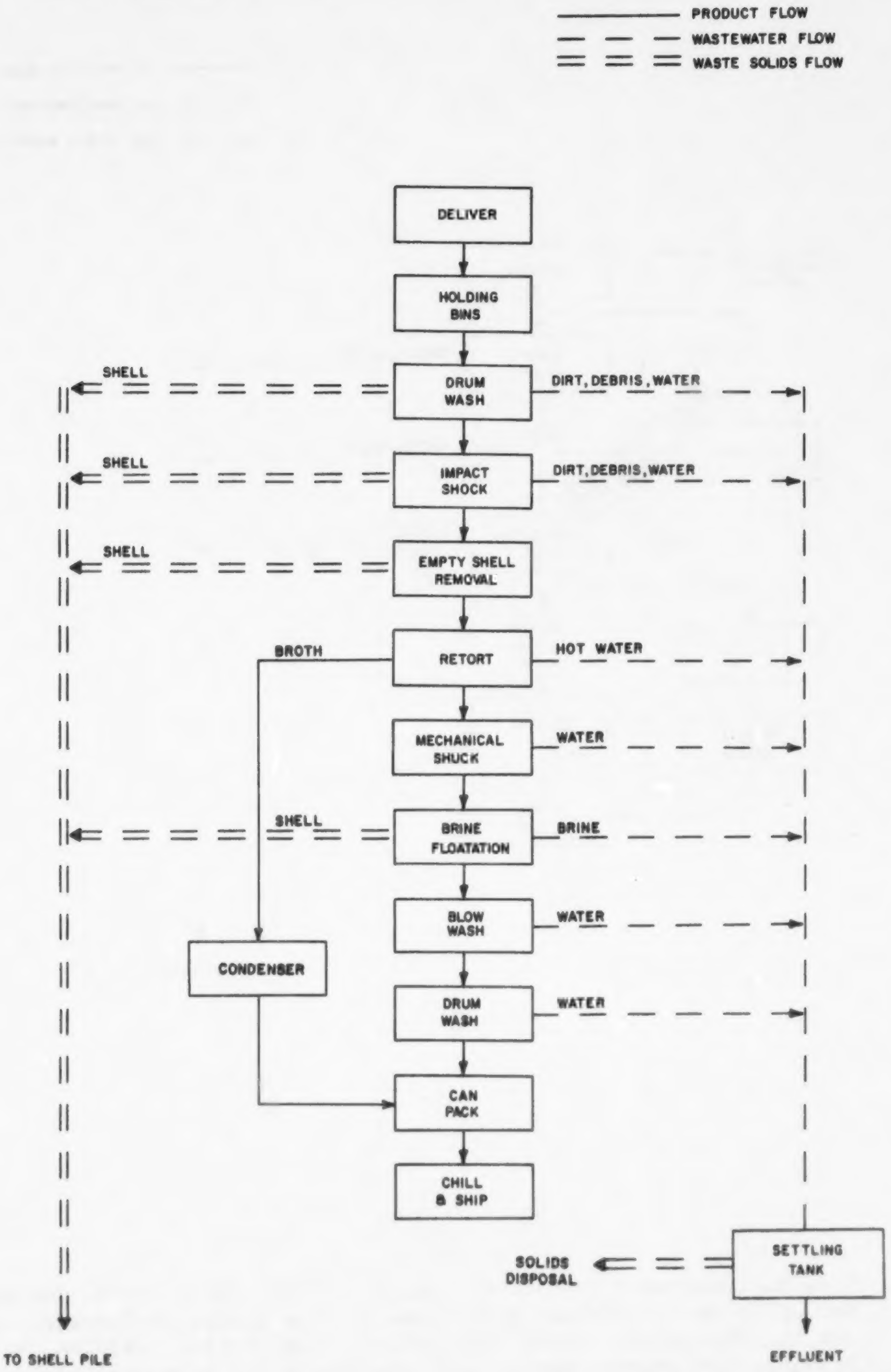
Scallops (with the exception of calico scallops) are generally shucked at sea and are received at the plant in cloth bags. The only meat used in the

Figure 22. Flow diagram for a typical hand-shucked oyster processing plant.


DELIVER
HOLDING BINS
SHUCK
SHELL
GRADE
DRAIN
WATER
SPRAY WASH
WATER
BLOW WASH
WATER
OR
BREAD
QUICK FREEZE
PACK, FREEZE & SHIP
PACK
CHILL & SHIP
TO SHELL PILE
EFFLUENT

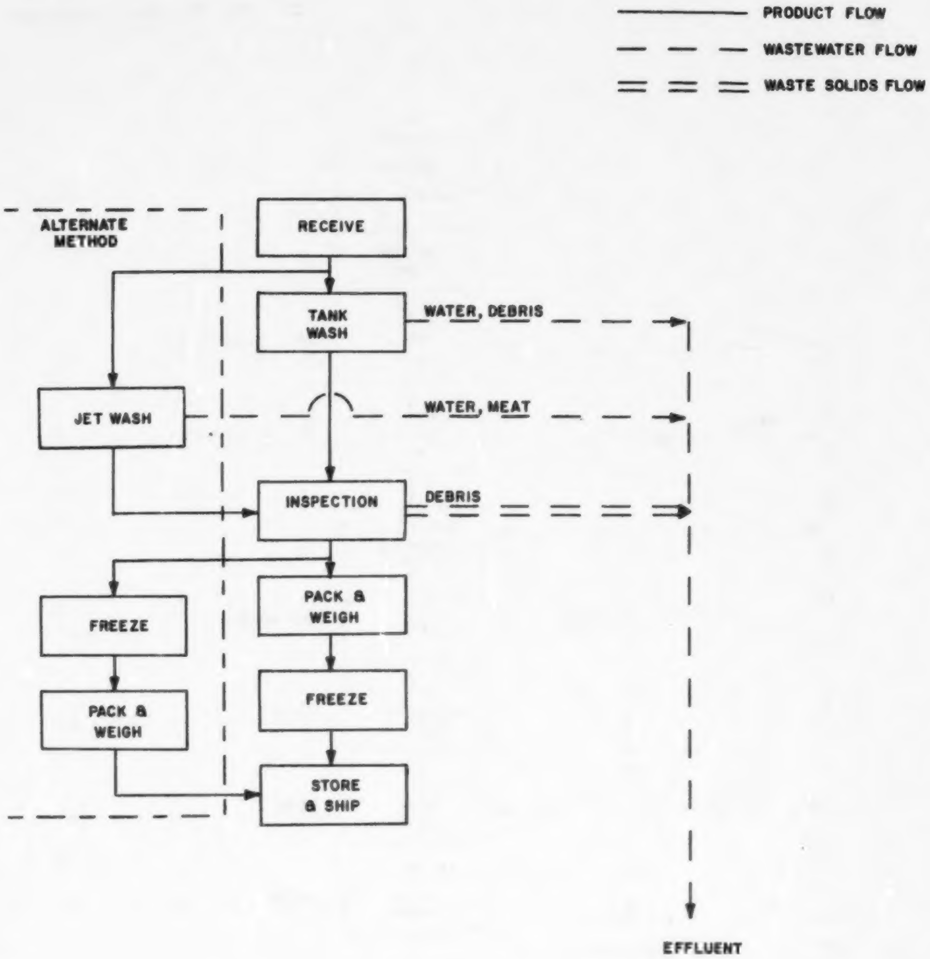
Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

Figure 23. Flow diagram for a typical steamed or canned oyster processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
DELIVER
HOLDING BINS
SHELL
DRUM WASH
DIRT, DEBRIS, WATER
SHELL
IMPACT SHOCK
DIRT, DEBRIS, WATER
SHELL
EMPTY SHELL REMOVAL
BROTH
RETORT
HOT WATER
MECHANICAL SHUCK
WATER
SHELL
BRINE FLOATATION
BRINE
BLOW WASH
WATER
CONDENSER
DRUM WASH
WATER
CAN PACK
CHILL & SHIP
SOLIDS DISPOSAL
SETTLING TANK
TO SHELL PILE
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

Figure 24. Flow diagram for a typical scallop processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
ALTERNATE METHOD
RECEIVE
TANK WASH
WATER, DEBRIS
JET WASH
WATER, MEAT
INSPECTION
DEBRIS
FREEZE
PACK & WEIGH
PACK & WEIGH
FREEZE
STORE & SHIP
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

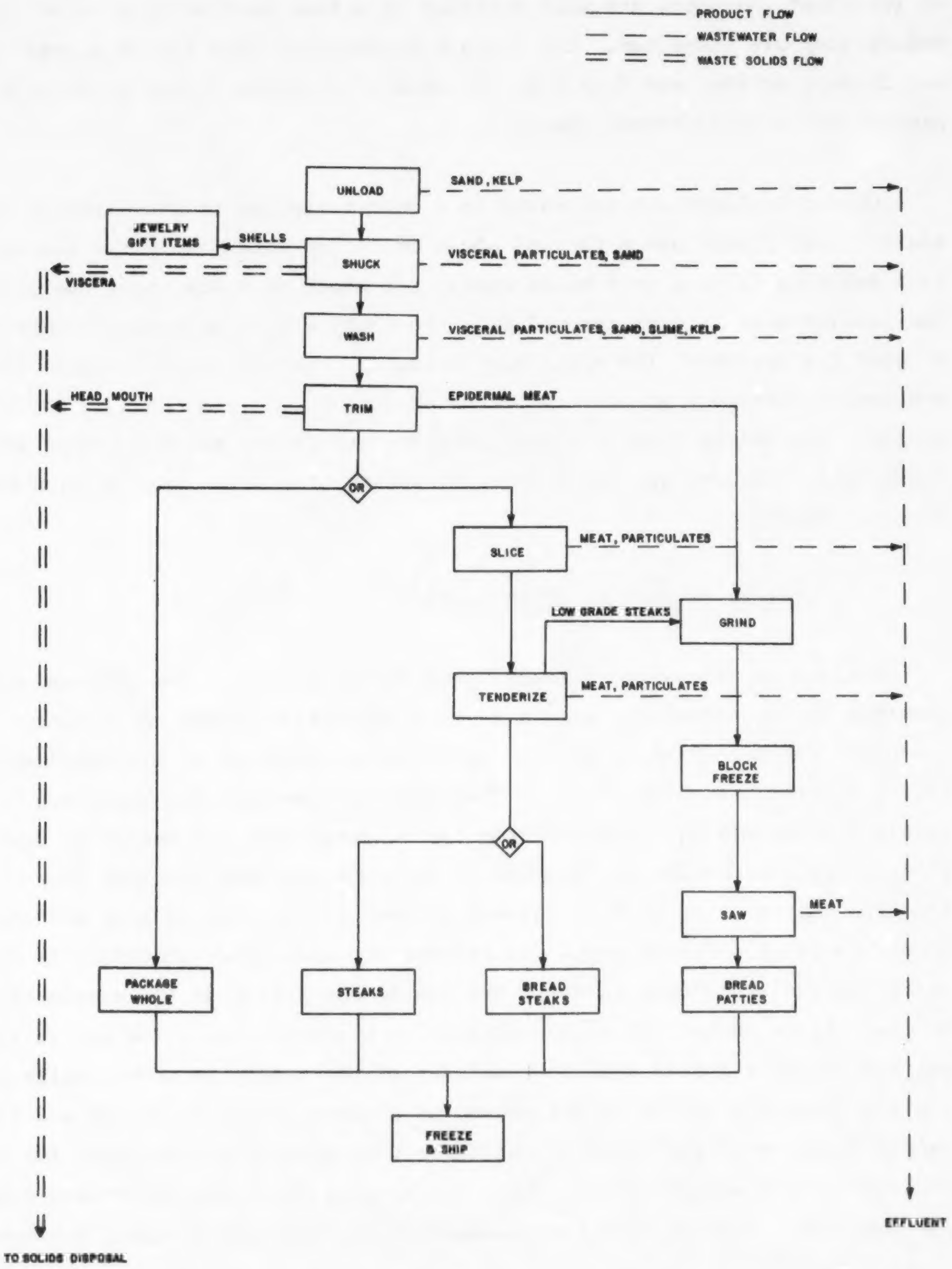
scallop is the adductor muscle and all other meat is discarded. Upon receipt at the plant the meats are washed either in a tank wash or in a spray wash before they are inspected. The inspected meats are then either packed, weighed, and frozen, or they are frozen by the Individual Quick Freeze (IQF) method, packed, and weighed before shipping.

Calico scallops are processed in a manner similar to mechanically shucked clams. Some plants use a thermal shock technique which heats the scallop and then subjects it to a cold water spray, the shock of which opens the scallop. The scallop meat is then removed from the shell with a mechanical shucker such as used for oysters. The meats are separated from the shell by brine flotation and passed through a grinder-roller which removes the viscera from the adductor muscle. The muscle then is washed, sorted, and packed and the ground viscera discharged. The average yield is eight pounds of scallop meat per two bushels of shell stock.

Abalone Processing (Figure 25)

Abalone is processed exclusively on the West Coast. The abalone are received at the processing plants in lots segregated according to species and the diver who harvested them. The meats are punched out of the shell with the aid of an iron bar. The shell is then sold for jewelry or decorations. The edible foot muscle is separated from the visceral mass and washed by one of several types of mechanical washers. The mouth and head sections are cut away from the foot and the foot is allowed to rest for an hour or more for the muscle to relax. If the muscle is trimmed too soon after shucking, it is still excitable and hard to cut. The mantle and lining of the muscle is removed with a mechanical slicer similar to a meat slicer. The pad is then cut off the foot muscle and the remainder of the muscle is mechanically trimmed. The trimmings are collected and canned as abalone pieces or ground and frozen before being sawed into patties which are then breaded and packaged for freezing. The foot is sliced into steaks which are breaded and frozen or frozen unbreaded for shipment. Some abalone are packaged whole after the trimming process and frozen.

Figure 25. Flow diagram for a typical abalone processing plant.


PRODUCT FLOW
WASTEWATER FLOW
WASTE SOLIDS FLOW
UNLOAD
SAND, KELP
JEWELRY GIFT ITEMS
SHELLS
SHUCK
VISCERAL PARTICULATES, SAND
VISCERA
WASH
VISCERAL PARTICULATES, SAND, SLIME, KELP
HEAD, MOUTH
TRIM
EPIDERMAL MEAT
OR
SLICE
MEAT, PARTICULATES
LOW GRADE STEAKS
GRIND
TENDERIZE
MEAT, PARTICULATES
BLOCK FREEZE
OR
SAW
MEAT
PACKAGE WHOLE
STEAKS
BREAD STEAKS
BREAD PATTIES
FREEZE & SHIP
TO SOLIDS DISPOSAL
EFFLUENT

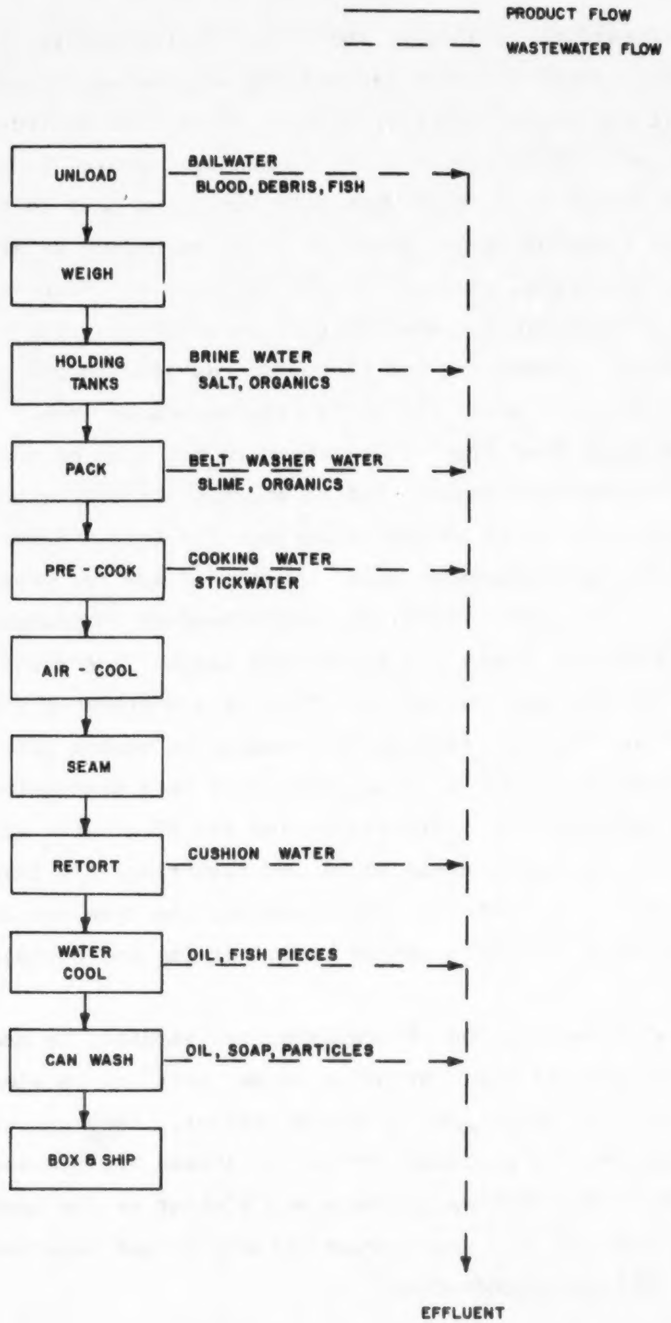
Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75 041a.

1.2.2.17 Sardine Processing (Figure 26)

Most sardine canning in the United States occurs along the New England coast where small immature sea herring are canned as sardines. The fish arrive at the plant either by boat or truck. If by truck, the fish are flushed out with water hoses and flumed or conveyed to the receiving area. Fish are pumped from ships with fish pumps and sent to the receiving area either by flume or by dry conveyor. The unloading water usually is discharged back into the tidal waters. If the fish are not processed immediately they are placed in a refrigerated salt brine solution. The fish are dipped out of the tanks or flushed out and flumed or conveyed to the cutting and packing tables. Here the heads and tails are removed by hand. Any fish remaining on the continuous feed line are returned to the head of the production line. The heads and tails are transported to storage hoppers or to trucks for sale to fishmeal plants or to lobster fishermen for bait. After the sardine cans are packed, they are placed on racks in a steam box for precooking. The fish are then cooked at 100°C (212°F) for approximately 30 minutes. The cans are removed from the cooker and any excess liquid is drained off the cans. This mixture of oils and aqueous materials is a wastewater stream. The cans are sealed by machine and then machine-washed to remove oils and bits of fish from the can exterior. The washing water also is a wastewater source. The washed cans are placed in a retort and cooked for 60 minutes at 113°C (235°F) unless mustard or tomato sauce was added for flavoring. In that case, the time is reduced to fifty minutes. After cooking, the cans are cooled in a retort by water flooding and again washed before drying and boxing.

An alternate method of preparing the sardines is now being used to increase the overall yield by using larger herring. A steaking machine is used to cut the fish in a cross-sectional manner. Waste materials are flumed to treatment/recovery processes while the steaks are transported to the packing area. The other processing steps are similar to the hand-cutting system. However, this process uses a considerably larger quantity of water and has a greater pollutant generation.

Figure 26. Flow diagram for a typical sardine processing plant.


PRODUCT FLOW
WASTEWATER FLOW
UNLOAD
BAILWATER
BLOOD, DEBRIS, FISH
WEIGH
HOLDING TANKS
BRINE WATER
SALT, ORGANICS
PACK
BELT WASHER WATER
SLIME, ORGANICS
PRE - COOK
COOKING WATER
STICKWATER
AIR - COOL
SEAM
RETORT
CUSHION WATER
WATER COOL
OIL, FISH PIECES
CAN WASH
OIL, SOAP, PARTICLES
BOX & SHIP
EFFLUENT

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

1.2.2.18 Herring Filleting: Alaskan and Non-Alaskan (Figure 27)

The herring are received at the plants by boat or by bulk truck in a descaled condition and are then pumped into the plant. From boats they sometimes may be packed into totes for transport to the plant. Processing of the fish may depend upon the season as well as the current markets. For preparing fillets, the fish are aligned into grooves in the automatic filleting machine. The heads and tails are removed and the fish eviscerated and filleted in one machine. The freshly cut fillets are flumed to a sorting station. Here faulty fillets are repaired manually. The viscera and other waste parts are flumed to the reduction plant or to discharge. The fillets are either boxed and frozen or sent to be pickled. The fish are filleted during the late fall and winter months as described above. During the spawning season, the fish may be discarded after the roe is stripped for sale. The herring also might be frozen in the round for transport to Japan, where the roe can be stripped and the carcass processed. Another option is to freeze the herring for use as crab and halibut bait.

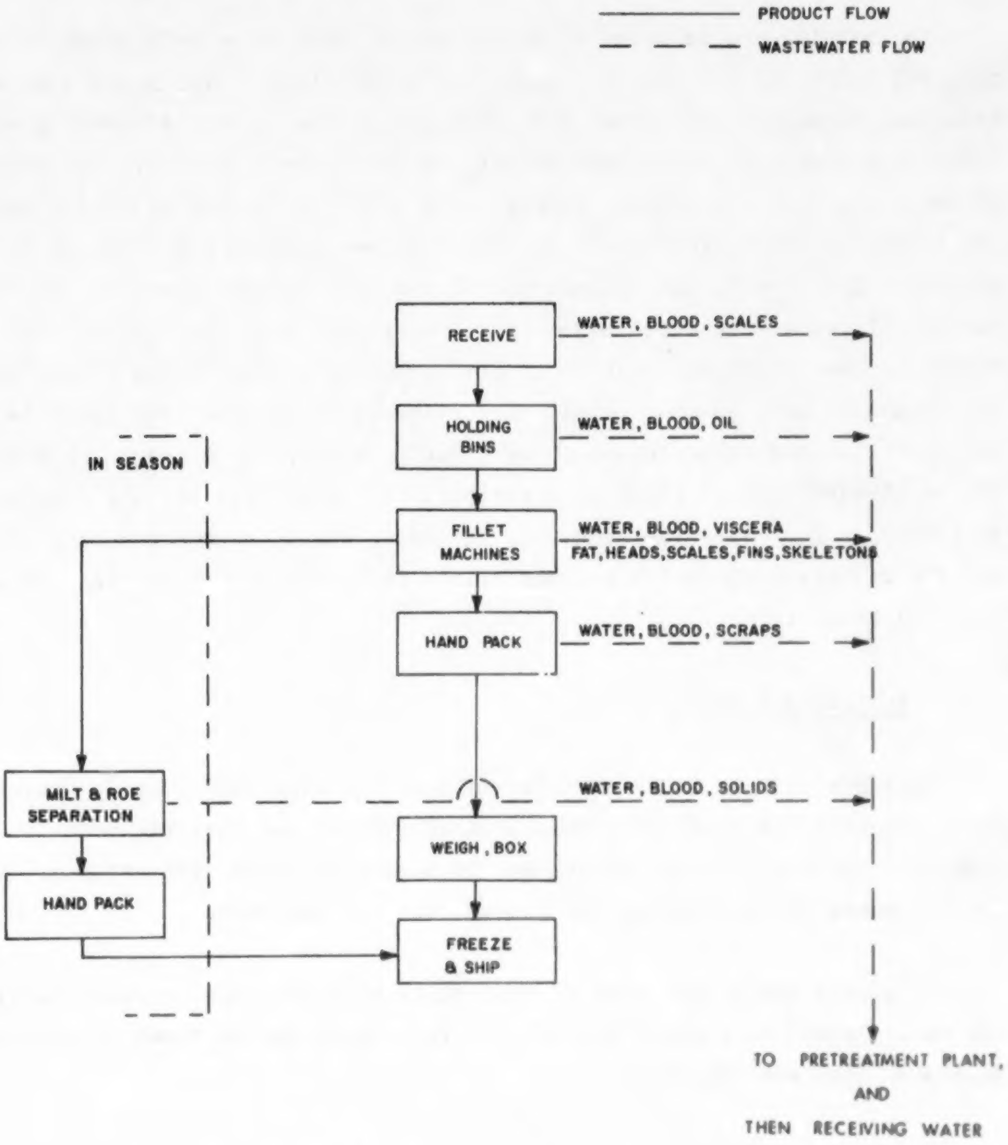
1.2.3 Auxiliary Support Systems

Most seafood plants in urban areas need few auxiliary support systems. Water generally is supplied from municipal systems and electric power is readily available. Boiler plants may be needed to supply the necessary steam and hot water for processing the product and for washdown.

At plants where unloading of seafood is by fish pumps, a water supply system is needed to support unloading. This water may be fresh or salt water depending upon availability.

In remote areas such as Alaska, most canneries buy their can stock in rolls and manufacture cans at the plant or the cans are preformed and flattened before shipment. The cans are then reformed at the plants and the end units are installed. Finally the can is tested for tightness before going into the can storage area.

Figure 27. Flow diagram for a typical herring fillet processing plant.


PRODUCT FLOW
WASTEWATER FLOW
RECEIVE
WATER, BLOOD, SCALES
HOLDING BINS
WATER, BLOOD, OIL
IN SEASON
FILLET MACHINES
WATER, BLOOD, VISCERA
FAT, HEADS, SCALES, FINS, SKELETONS
HAND PACK
WATER, BLOOD, SCRAPS
MILT & ROE SEPARATION
WATER, BLOOD, SOLIDS
WEIGH, BOX
HAND PACK
FREEZE & SHIP
TO PRETREATMENT PLANT, AND THEN RECEIVING WATER

Source: U.S. Environmental Protection Agency. 1975c. Development document for effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, clam, oyster, sardine, scallop, herring, and abalone segments of the canned and preserved fish and seafood processing industry point source category. EPA-440/1-75-041a.

In Alaska, there is a high percentage of floating processing plants (Kawabata 1980). Floating processing plants differ in their requirements and may need specialized auxiliary support systems such as refueling barges, sources of fresh water, electric generators, and a means of landfilling rubbish generated on-board. Floating processers can create impacts on small rural communities, which are not able to provide adequate supplies of fuel, water, or electricity. Special consideration to auxiliary support equipment should be given in these cases.

Most remote plants have to supply all the electricity and heat needed for running the plants. Because little housing is available, mess hall and dormitory space is provided for employees. Auxiliary systems for a facility of this kind would include all life support services necessary for the workers during the period of employment.

1.3 SIGNIFICANT ENVIRONMENTAL PROBLEMS

1.3.1 Location

Most of the larger seafood processing plants in the Pacific Northwest are expected to be built in remote areas near the fishing grounds, while elsewhere in the United States plants would be built in coastal fishing villages. The most effective mitigative measure appears to be siting the plant where the least number of persons will be impacted by it. Site locations of this sort occur naturally in some areas where such facilities are located in coves along the shoreline near good anchorages. An additional important siting consideration is the potential impact which the facility might have on environmentally sensitive areas including wetlands, wild and scenic rivers, wilderness areas, habitat for endangered or threatened species, and spawning or nursery grounds for wildlife and fish. These can be avoided by conducting site screening studies in which various alternative facility locations are considered.

Nearly all seafood processing plants are located on bodies of water because of the necessity of being near the fishing boatports and an adequate supply of processing, cooling, and washdown water. Because of this proximity to water, most wastewaters ultimately are discharged back into the water course. Compliance with applicable NSPS to be imposed by USEPA or with the even stricter Section 302 site-specific effluent limitations of P.L. 92-500 should minimize potential impacts on receiving water bodies.

Where new or expanded seafood processing plants are proposed for primitive areas, the facility location could be a significant factor. Although most seafood processing plants have few air emissions, those generated by auxiliary facilities (e.g., power generating plants, fish mealing operations, and solid waste incinerators) could create problems. All proposed facilities are subject to a Prevention of Significant Deterioration (PSD) review by USEPA, and those plants proposed for such areas will be subject to standards which should serve to minimize degradation of existing air quality. Where a plant is proposed for an area of air quality nonattainment, emissions would be controlled so as not to violate ambient air quality standards.

Seafood processing plants, although usually relatively small in size, can involve a significant change in land use patterns. The magnitude and significance of secondary or indirect impacts, such as induced growth, infrastructure changes, and demographic changes will depend largely on the local economy, existing infrastructure (if any), numbers and characteristics of construction workers (e.g., local or non-local, size of workers' families), and other related factors. The long-term secondary impacts for a new processing plant or group of plants can be significant. A significant increase in area employment as well as the cash associated with materials purchases can lead to the creation of a town.

1.3.2 Raw Materials

The raw materials for seafood processing are food grade materials in general except for spoilage losses due to improper handling or preservation. Unloading and handling of raw seafoods creates a potential for environmental degradation from the contaminated unloading water, and contaminated ice and brines used to preserve fish on the high seas. Fuel oil leaks or spills also should be considered, and procedures should be established to minimize the impacts that could result from such discharges.* Raw water supplies may include either fresh water or salt water. Raw material trends and impacts are further discussed in Section 1.4.3 and Chapter 2.0.

1.3.3 Processes and Pollutants

The major characteristics of raw waste loads for the industry are presented in Table 3, according to the major processes occurring in a seafood processing plant. Except where chlorination of wastewaters is required, there are no toxic or hazardous wastes generated by seafood processing, and most pollutants (with the exception of shells and bones) are highly biodegradable. High residual chlorine levels were reported in effluent from seafood processing plants in Maryland (Brinsfield and Phillips 1977). These levels could pose a potential threat to aquatic life in receiving waters. Also, in these studies it was shown that the chlorination method was not always effective in reducing total fecal coliform counts in the effluent.

The major components of seafood processing wastewater are blood, tissue liquids, meat, viscera, oils, and greases. The major ecological effects are depression of the dissolved oxygen in the water column and on the bottom caused by the rapid decomposition of the wastes and the subsequent distress or death of organisms. In extreme cases, seafood wastes can cause thick anaerobic sludge formation which can release hydrogen sulfide and methane into the water. These gases are particularly toxic to fish and can have a devastating effect in small bays with little current or flushing action. Nutrients such

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*The impacts associated with harvesting the seafood may also present environmental problems distinct from those at the plant site. While these impacts are of concern, they are beyond the scope of this guidance document. It is the policy of the Office of Federal Activities (OFA) that the responsibility for assessing the environmental impacts of new source industries be limited to those impacts directly caused or induced by site-specific development and operation activities. Therefore, the applicant's EID must address the impacts of fishing and vessel activities only if it is an integral part of the [illegible] for which application is made. However, [illegible] that can be processed should be considered in the EID, as this could create a serious solid waste disposal problem.

Table 3. Major characteristics of process raw waste loads for the seafood processing industry.

Activity	Characteristics
Unloading	Suspended and dissolved organic and inorganic matter
Receiving	Suspended and dissolved organic and inorganic matter
Butchering	Suspended and dissolved organic matter
Cooking	Suspended and dissolved organic matter
Canning	Suspended and dissolved organic matter
Freezing	None identified
Washing	Suspended and dissolved organic matter
Rendering	Suspended and dissolved organic matter

as nitrogen and phosphorus released by the digesting sludges can stimulate algal growth. Seafood processing plants may introduce elevated levels of chloride and ammonia ions into receiving waters, which could pose potential toxicity problems. Ammonia is produced by the decomposition of high protein seafood waste material, whereas chloride arises from processes which employ saline cooks, brine freezing, brine separation tanks (for separating meat from shell), or seawater for processing (USEPA 1975d).

The major air pollution problems associated with seafood processing are generally odors and product dust from mealing operations. The major process-oriented solid waste problems include:

- Shells from oyster, clam, scallop, crab, and shrimp processing.
- Bones and skin from butchering, filleting, and fish flesh processing.
- Fish heads from beheading operations.
- Viscera from butchering of fish and shellfish.
- Deformed cans from filling and seaming operations.

Disposal of solid wastes from seafood processing plants presents a potentially significant environmental problem. If not disposed of in the correct manner, significant accumulations of organic material can occur, which can reduce water quality and smother benthic life. Studies in Alaska (Bechtel 1979, [illegible] 1979, [illegible] 1980) have been conducted which illustrate some of these problems. The major problems are related to:

- Impacts of highly seasonal discharges of large volumes of ground waste by land-based plants in remote areas.
- Choice of suitable disposal sites for disposal of screened and recovered wastes in non-remote areas and high cost of this method of treatment.
- Impacts of disposal of wastes by floating processing plants in remote areas, which is one of the most common practices in Alaska ([illegible] 1980).

Potential impacts on the marine environment resulting from disposal of seafood waste may include the following:

- Large accumulations of seafood process waste may occur if such discharges occur in poorly flushed, low energy protected environments. These accumulations smother benthic organisms and reduce ambient water quality due to reductions in dissolved oxygen levels, and may cause the release of H_2S as the piles of waste decompose.

- Disposal in shallow (25 feet) high energy waters has the advantage of more rapid dispersion, but can significantly alter the substrate by burial with heavier, less easily sorted shell fragments. The potential impacts of such discharges can be increased greatly if several discharge pipes are located close to one another (NOAA 1980).

- Disposal of the wastes in deeper water (at least 40 feet) in low energy areas slightly offshore, may result in a substantial accumulation of wastes. Recolonization of such accumulations is reported to not begin until three years after the pile has decomposed (Bechtel 1979). Disposal in extremely deep ocean areas is an alternative to this problem, but it is costly.

1.3.4 Pollution Control

Odors generated by pollution control equipment could be a problem with the industry due to the highly biodegradable nature of the waste products. However, a properly maintained raw waste screening system should not produce any odors of public significance. Where dissolved air flotation is used, the solids and oils entrained with air will not generate significant odors if removed and processed immediately. A well-designed and operated primary or secondary aerobic system should not produce obnoxious odors. Odor problems should be minimal in land application of well-digested or stabilized treatment plant sludges, but any undigested sludges spread on the land would certainly create odor and insect problems as well.

Solid wastes not promptly removed from a seafood processing plant could create odors and insect problems because of the highly putrescible nature of seafoods. However, a well-operated and maintained solid waste disposal system will obviate these problems. The air pollution control equipment on rendering plants should not create any solid waste problems as the product dust from drying is normally recycled back into the meal. The air scrubbers will remove organics which will not create a major problem with solids disposal, but the organics contained in the water are highly biodegradable and can be treated properly to avoid water pollution control problems.

1.4 TRENDS

The Fisheries Resource Conservation Act (FRCA) has had and continues to have a major effect on the industry. The industry trends have been patterned to the increased use of stocks protected by the 200 mile limit, especially new stocks such as bottomfish. The new stock utilization patterns have been complemented and encouraged by processing modifications as well as environmental regulations.

1.4.1 Markets and Demands

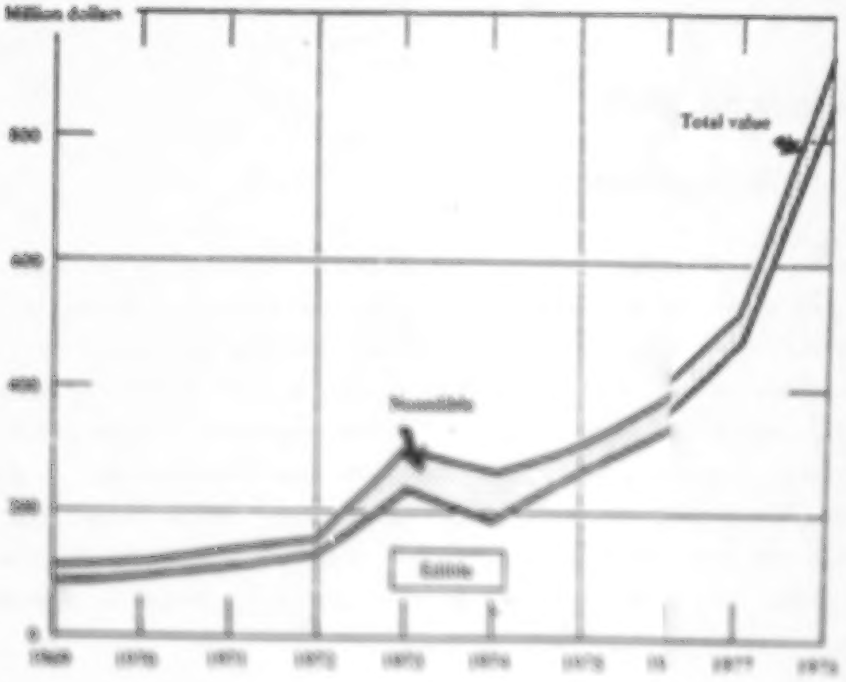
1.4.1.1 Foreign Markets

The export of edible fisheries products has steadily grown from 140.6 million pounds in 1969 to a record weight of 448.3 million pounds in 1978 (NOAA 1979b). The value of edible fisheries products exports was a record $831.6 million in 1979, with non-edible exports a record $73.9 million. Of the edible exports, 47% went to Japan, 13% to Canada and the remaining exports were scattered throughout the world. Japan is the largest buyer of frozen king crab; fresh and frozen salmon steaks, fillets, and portions; and fresh and frozen salmon. Figure 28 presents the value of US exports for the years 1969 to 1978. The reduction in quotas for foreign fisheries is expected to maintain a strong American export market.

1.4.1.2 Domestic Markets

The average per capita consumption of commercial fish and shellfish has been 11 pounds for the period of [illegible] to 1978 (NOAA 1979b). This has been a fairly constant consumption rate, except for the depression years ([illegible] to [illegible]) and during World War II ([illegible] to [illegible]). The average consumption since [illegible] has been [illegible] pounds, indicating that there is a constant and steadily increasing market and demand within the US. In 1978, the reported demand for the average US consumer was [illegible] pounds, including [illegible] pounds of fresh and frozen products, [illegible] pounds of canned products, and [illegible] pounds of cured products.

Figure 28. Value of US exports of domestic fishery products for 1969 to 1978.



Source: National Oceanographic and Atmospheric Administration. 1979b. Fisheries of the United States, 1978. Current Fishery Statistics No. 7800.

Through 1977 over 50% of the US supply of edible commercial fisheries products was imported. In 1978, although imports dropped to 39% of the consumption, a record 4,985,000 pounds were imported. Table 4 shows the US supply of fishery products for the years 1969 to 1978. It would appear that the domestic market for fisheries products will continue to grow for the immediate future.

1.4.2 Locational Trends

The regional distribution of seafood processing plants is presented in Table 5 for the period from 1975 through 1977 (NOAA 1979b). The major locational changes in plants are expected to occur in the Pacific Northwest and Alaska and, to a lesser degree, in the Northeast* and Gulf regions. Since the Pacific bottomfish harvests before the passage of FCMA traditionally went to foreign fleets, several new plants are expected to be established each year for the next several years.

Another trend in the Pacific Coast region is toward floating processing plants instead of shore-based plants. These will allow greater mobility for the processor who can move closer to the stocks being harvested. The declining harvest of East Coast surf clams also has initiated interest in Alaskan surf clam stocks. Thus far only limited stock surveys and test harvesting have occurred, but there are indications that a considerable fishery could be developed in this region.

The trend in locating seafood processing facilities also is indicated by the pattern for the construction of fishing vessels. As shown in Figure [illegible], there was an increase of 477 vessels constructed in 1977, to a total of 1,383. The distribution by region of fishing boat construction for the years 1975 to 1977 indicates that the Gulf Coast and Pacific Coast regions should continue with the fisheries industry expansion, as will the Atlantic Coast.

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*The smaller projected impact in the Northeast region is due to existing bottomfish plants that could be consolidated to handle the increased fishery made available by FCMA.

Table 4. US supply of edible commercial fishery products, 1969-78 (quantity on round-weight basis).

Year	Domestic Commercial Landings		Imports (1)		Total
	Million pounds	Percent	Million pounds	Percent	Million pounds
1969	2,321	40.9	3,353	59.1	5,674
1970	2,537	40.8	3,676	59.2	6,213
1971	2,441	40.5	3,582	29.5	6,023
1972	2,435	35.3	4,454	64.7	6,889
1973	2,398	33.7	4,709	66.3	7,107
1974	2,496	37.6	4,142	62.4	6,638
1975	2,465	38.6	3,929	61.4	6,394
1976 (2)	2,760	37.4	4,629	62.6	7,389
1977 (2)	2,900	39.1	4,514	60.9	7,414
1978 (2)	3,177	60.9	4,958*	39.1	8,135*

(1) Excludes imports of edible fishery products consumed in Puerto Rico, but includes landings of foreign-caught tuna in American Samoa.
(2) Preliminary.
* Record. Record US landings were 3,307 million lbs. in 1950.

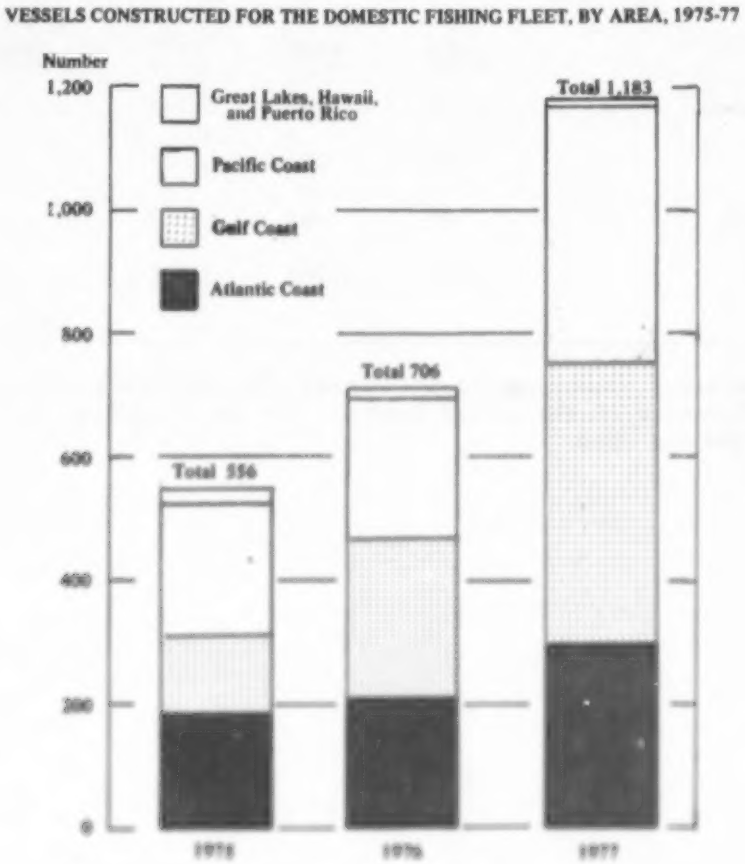
Source: National Oceanographic and Atmospheric Administration. 1979b. Fisheries of the United States, 1978. Current Fishery Statistics No. 7800.

Table 5. Processing and wholesale plants in the United States by selected regions, 1975 to 1977.

Region	1975	1976	1977	Percent change 1975 - 1977
Atlantic Coast	1,776	1,793	1,743	-2
Gulf Coast	723	726	745	+3
Pacific Coast	587	587	621	+6
Totals	3,086	3,106	3,109	+0.7

Source: National Oceanographic and Atmospheric Administration. 1978b, 1979b. Fisheries of the United States. Current Fisheries Statistics Nos. 7500 and 7800.

Figure 29. Vessels constructed for the domestic fishing fleet by area for the period of 1975 to 1977.



Source: National Oceanographic and Atmospheric Administration. 1979b. Fisheries of the United States, 1978. Current Fishery Statistics No. 7800.

1.4.3 Trends in Raw Materials

The major industry trend in raw materials is the increased interest in and utilization of bottomfish for harvesting and processing. There also is a potential for the processing of trash fish caught with bottomfish and shrimp into fish protein, but this has not yet occurred. There have been increased catches in the Pacific salmon and herring stocks, but this may be only normal biological upswing and not a result of the establishment of the Fisheries Conservation Zone.

1.4.4 Process Trends

The industry is increasing the use of mechanical butchering and steak cutting equipment in place of hand operations. This is a particularly important trend because the mechanized processes tend to have a greater impact due to an increased raw waste load. There was very little change reported from 1976 to 1978 in the mix of fresh, frozen, canned, and breaded seafoods, as shown in Table 6. This product mix probably will remain the same for the immediate future, indicating that a major shift in processing trends is not probable.

1.4.5 Pollution Control

Since the enactment of more stringent laws and regulations governing the control of pollutants, efforts have been made to develop new and improved technologies for treatment of seafood wastes. Consequently, relatively rapid changes in pollution control technology are occurring in the industry, along with the installation of more sophisticated equipment to handle waste loads. Improved pollution control methods are expected to focus on the following areas.

Raw Materials Handling

Vacuum vessel unloading systems are expected to gain wider acceptance over fish pumps because they reduce water pollution in the plant area. In-plant controls to reduce water usage are expected to include installation of better mechanical processing equipment and improved operations within the

Table 6. Quantities of processed fishery products for the years 1976, 1977, and 1978.

Process	1976 Thousand Pounds	%	1977 Thousand Pounds	%	1978 Thousand Pounds	%
Fresh and frozen fillets and steaks	142,585	9	160,388	10	161,283	9
Fish steaks	94,169	6	87,230	5	93,158	5
Fish portions	344,284	22	355,443	22	386,611	21
Breaded shrimp	95,923	6	97,718	6	107,973	6
Canned shellfish	117,626	7	133,028	8	118,468	7
Canned fish	789,495	50	790,672	49	951,829	52
Totals	1,584,082	100	1,624,439	100	1,819,322	100

Source: National Oceanographic and Atmospheric Administration. 1978b, 1979b. Fisheries of the United States. Current Fisheries Statistics Nos. 7500 and 7800.

plant. Less water will be used to transport product and wastes, and a greater effort will be made to dry capture solid wastes from the production process. This will reduce the amount of water to be processed along with the waste and should decrease by-product recovery operating costs.

By-product Recovery

New technologies also are being developed to utilize materials which are now lost or wasted. Increased pressure to reduce the pollutional load on water bodies, along with resistance toward landfilling seafood solids, is expected to increase efforts to manufacture by-products from the viscera, heads, and unused portions of seafoods. The trend is toward reduction into meals, oils, and solubles, or to seafood protein concentrates for animal food additives, fertilizers, and industrial chemicals.

Wastewater

The use of activated sludge wastewater treatment systems with the subsequent use of the sludge for animal food appears to be one method to reduce the pollution load while developing a feasible by-product from the wastes, but this is not close to commercial development. Dissolved air flotation (DAF) as a method of removing oils and suspended solids from seafood wastes is in full scale use for tuna, shrimp, and salmon. Recent studies indicate that, combined with chemical feeding, DAF does an acceptable job.

Odor Control

The industry is controlling odors to a greater extent by improving the removal and recovery of waste materials.

1.6.6 Environmental Impact Trends

The increased harvesting of seafoods is expected to be met by utilization of unused capacity, automation of production lines, enlarged plant facilities, and, in the Pacific Northwest, by construction of new facilities. Although the modernization of production lines and enlargement of plants can have a strong local aesthetic impact, the trend toward countywide land use planning should reduce the mistakes of the past when industrial zoning, if it existed, was confined primarily to municipal communities. Environmental pollution from new or expanded processing plants may impact local and regional environs to different degrees depending on site-specific conditions, the type of facility proposed, and the extent of pollution control and other mitigative measures.

Air Quality

The impact on air quality of new plants constructed in pristine areas will be minimized by the prevention of significant deterioration (PSD) regulations discussed in Section 1.5.2. The net impact of the emissions of new or expanded facilities planned for industrialized areas also should be less than in the past because of USEPA's offset regulations, also discussed in Section 1.5.2.

Water Quality

While new plants have the advantage of incorporating new or improved processes to treat liquid effluents, USEPA's background studies to establish effluent guidelines and standards (USEPA 1974a, USEPA 1975b) found no significant correlation between age of the plant and raw wasteload. Many older plants have been upgraded and modernized to remain competitive with new plants, and as a result have been required to install modern waste treatment facilities. Many new plants are highly mechanized, and the strengths of wastes vary with the degree of mechanization, with highly automated plants generally using more water and producing more pollutants.

The selected discharge location may have a significant impact on the water quality of the receiving water body. One of the most critical factors is to locate the discharge in an area with good circulation to avoid the accumulation of settleable solids. The applicant must be careful to distinguish between a high tidal range (i.e., the difference between the high and low tide elevation) and a high tidal exchange (i.e., the volume of water exchanged during a tidal cycle). The discharge location also may have a negative effect on other industrial facilities using the receiving body for industrial water supply.

Geographic Impacts

Treatment problems are associated with climatic variation, with higher treatment costs in Alaska. In highly populated metropolitan areas there will be more processing plants, but by-product recovery will be more economically feasible than in more remote areas. Plants planned for remote areas of the Pacific Northwest may face the problem of establishing solid waste disposal sites. In some areas these sites may be on or adjacent to wildlife refuges. Also, the remoteness of the area makes salvage and recycling of materials and equipment economically infeasible. These factors can lead to increased solid waste disposal problems.

1.5 REGULATIONS

1.5.1 Water Pollution Control Regulations

The Federal Water Pollution Control Act (FWPCA) Amendments of 1972 (P.L. 92-500) established two major, interrelated procedures for controlling industrial effluents from new sources, and specifically included seafood processing plants in the list of affected categories of sources. The principal mechanism for discharge regulation is the NPDES permit. The other provision is the new source performance standard. The Clean Water Act of 1977 (P.L. 95-217), which amends P.L. 92-500, made no change in these basic procedures. The Clean Water Act of 1977, however, did direct USEPA to study the geographical, hydrological, and biological characteristics of marine waters to determine the effects of seafood processes which dispose of untreated wastes into the waters. Also, it directed that a study of technologies be made to facilitate the use of the nutrients in seafood wastes or to reduce the discharge.

The NPDES permit, authorized by Section 402 of FWPCA, prescribes the conditions under which effluents may be discharged to surface waters. The conditions applicable to new or expanded seafood processing plants will be in accordance with NSPS, adopted by USEPA pursuant to Section 306, and pretreatment standards promulgated to implement Section 307(b). Different standards will be applicable depending on the subcategory of the process under consideration. Stricter effluent limitations may be applied on a site-specific basis if required to achieve water quality standards. Effluent NSPS for the 33 subcategories of the seafood processing industry are shown in Table 7. These NSPS are based on kg. of pollutant per 1000 kg. of raw material For facilities that are not covered by this subcategorization scheme, effluent standards are established by USEPA on a case-by-case basis.

One of the most important regulatory requirements which a new source seafood plant will be required to meet involves dredging, filling, or construction activities in navigable waters. This will require obtaining a "Section 10" and a "Section 404" permit from the US Army Corps of Engineers. These permits are required in order to prevent obstructions to navigation and to avoid potential impacts on sensitive areas. Section 404 of the Federal Water Pollution Control Act (as amended, 33 USC §1344) regulates the discharge of dredged or fill materials into the waters of the United States, including wetlands. Section 10 of the River and Harbor Act of 1899 concerns permit requirements for construction of dam, dike, or other structures, or performing other work in navigable waters of the United States. Permit applications are reviewed by the US Fish and Wildlife Service, the National Marine Fisheries Service, and the USEPA. The US Coast Guard reviews new piers and docking facilities. The USEPA has ultimate veto power over the Corps decision regarding granting of the Section 10 or Section 404 permits, however.

The USEPA has established regulations that control the introduction of non-domestic wastes into publicly-owned treatment works. The pretreatment standards for new sources do not employ limitations for the following subcategories: farm raised catfish; conventional blue crab; mechanized blue crab; non-remote Alaskan crab; remote Alaskan crab; non-remote Alaskan whole crab and crab sections; remote Alaskan whole crab and crab sections; dungeness and tanner crab; non-remote Alaskan shrimp; remote Alaskan shrimp; northern shrimp - contiguous states; southern non-breaded shrimp - contiguous states; breaded shrimp - contiguous states; and tuna processing. Instead, the descriptive pretreatment standards are set forth in 40 CFR Part 403. Subject to the provisions of Part 403, the wastes from these subcategories may be introduced into publicly owned treatment works (POTW) except for the following:

Table 7. Promulgated and proposed Federal new source performance standards applicable to subcategories of the canned and preserved seafood processing point source category.

Subcategory	BOD_5				Total suspended solids				Oil and grease				pH
	1-day maximum		Maximum average of daily values for 30 consecutive days		1-day maximum		Maximum average of daily values for 30 consecutive days		1-day maximum		Maximum average of daily values for 30 consecutive days		
	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	
A. Farmed Raised Catfish	4.6	4.6	2.3	2.3	11.0	11.0	5.7	5.7	0.9	0.9	0.45	0.45	6.0-9.0
B. Conventional Blue Crab	0.30	0.30	0.15	0.15	0.90	0.90	0.45	0.45	0.13	0.13	0.065	0.065	6.0-9.0
C. Mechanized Blue Crab	5.0	5.0	2.5	2.5	13.0	13.0	6.3	6.3	2.6	2.6	1.3	1.3	6.0-9.0
Alaskan Crab Meat													
D. Non-Remote*	N/A	N/A	N/A	N/A	16.0	16.0	5.3	5.3	1.6	1.6	0.52	0.52	6.0-9.0
E. Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
Alaskan Whole Crab and Crab Sections													
F. Non-Remote*	N/A	N/A	N/A	N/A	9.9	9.9	3.3	3.3	1.1	1.1	0.36	0.36	6.0-9.0
G. Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
H. Dungeness and Tanner Crab-Contiguous States	10.0	10.0	4.1	4.1	1.7	1.7	0.69	0.69	0.25	0.25	0.10	0.10	6.0-9.0
Alaskan Shrimp													
I. Non-Remote*	N/A	N/A	N/A	N/A	270.0	270.0	180.0	180.0	45.0	45.0	15.0	15.0	6.0-9.0
J. Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
K. Northern Shrimp - Contiguous States	155.0	155.0	62.0	62.0	38.0	38.0	15.0	15.0	14.0	14.0	5.7	5.7	6.0-9.0
L. Southern Non-breaded Shrimp - Contiguous States	63.0	63.0	25.0	25.0	25.0	25.0	10.0	10.0	4.0	4.0	1.6	1.6	6.0-9.0
M. Breaded Shrimp - Contiguous States	100.0	100.0	40.0	40.0	55.0	55.0	22.0	22.0	3.8	3.8	1.5	1.5	6.0-9.0

Table 7. Promulgated and proposed Federal new source performance standards applicable to subcategories of the canned and preserved seafood processing point source category (continued).

Subcategory	BOD_5				Total suspended solids				Oil and grease				pH
	1-day maximum		Maximum average of daily values for 30 consecutive days		1-day maximum		Maximum average of daily values for 30 consecutive days		1-day maximum		Maximum average of daily values for 30 consecutive days		
	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	
N. Tuna	20.0	20.0	8.1	8.1	7.5	7.5	3.0	3.0	1.9	1.9	0.76	0.76	6.0-9.0
O. Fish Meal	6.7	6.7	3.8	3.8	3.7	3.7	1.5	1.5	1.4	1.4	0.76	0.76	6.0-9.0
P. Alaska Hand-butchered Salmon													
Non-Remote*	N/A	N/A	N/A	N/A	2.3	2.3	1.4	1.4	0.28	0.28	0.17	0.17	6.0-9.0
Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
Q. Alaskan Mechanized Salmon													
Non-Remote*	N/A	N/A	N/A	N/A	42.0	42.0	25.0	25.0	28.0	28.0	10.0	10.0	6.0-9.0
Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
R. West Coast Hand-butchered Salmon	2.7	2.7	1.7	1.7	0.70	0.70	0.42	0.42	0.045	0.045	0.026	0.026	6.0-9.0
S. West Coast Mechanized Butchered Salmon	62.0	62.0	38.0	38.0	13.0	13.0	7.6	7.6	4.2	4.2	1.5	1.5	6.0-9.0
T. Alaskan Bottomfish													
Non-Remote*	N/A	N/A	N/A	N/A	1.9	1.9	1.1	1.1	2.6	2.6	0.34	0.34	6.0-9.0
Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
U. Non-Alaskan Conventional Bottomfish	1.2	1.2	0.71	0.71	1.5	1.5	0.73	0.73	0.077	0.077	0.042	0.042	6.0-9.0
V. Non-Alaskan Mechanical Bottomfish	13.0	13.0	7.5	7.5	5.3	5.3	2.9	2.9	1.2	1.2	0.47	0.47	6.0-9.0
W. Hand-shucked Clam	N/A	N/A	N/A	N/A	55.0	55.0	17.0	17.0	0.56	0.56	0.21	0.21	6.0-9.0
X. Mechanized Clam	15.0	15.0	5.7	5.7	26.0	26.0	4.4	4.4	0.40	0.40	0.092	0.092	6.0-9.0
Y. Pacific Coast Hand-shucked Oyster ***	N/A	N/A	N/A	N/A	45.0	45.0	36.0	36.0	2.2	2.2	1.7	1.7	6.0-9.0
Z. Atlantic and Gulf Coast Hand-shucked Oyster ***	N/A	N/A	N/A	N/A	23.0	23.0	16.0	16.0	1.1	1.1	0.77	0.77	6.0-9.0

Table 7. Promulgated and proposed Federal new source performance standards applicable to subcategories of the canned and preserved seafood processing point source (continued).

Subcategory	BOD_5				Total suspended solids				Oil and grease				pH
	1-day maximum		Maximum average of daily values for 30 consecutive days		1-day maximum		Maximum average of daily values for 30 consecutive days		1-day maximum		Maximum average of daily values for 30 consecutive days		
	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	kg/kkg of seafood	lb/1000lb of seafood	
AA. Steamed and Canned*** Oyster	67.0	67.0	17.0	17.0	56.0	56.0	39.0	39.0	0.84	0.84	0.42	0.42	6.0-9.0
AB. Sardine	N/A	N/A	N/A	N/A	36.0	36.0	10.0	10.0	1.4	1.4	0.57	0.57	6.0-9.0
AC. Alaskan Scallop***													
Non-Remote*	N/A	N/A	N/A	N/A	6.0	6.0	1.4	1.4	7.7	7.7	0.24	0.24	6.0-9.0
Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
AD. Non-Alaskan Scallop***	N/A	N/A	N/A	N/A	5.7	5.7	1.4	1.4	7.3	7.3	0.23	0.23	6.0-9.0
AE. Alaskan Herring Fillet													
Non-Remote*	N/A	N/A	N/A	N/A	23.0	23.0	18.0	18.0	20.0	20.0	7.3	7.3	6.0-9.0
Remote**	No pollutants may be discharged which exceed 1.27 cm (0.5 inch) in any dimension.												
AF. Non-Alaskan Herring Fillet	16.0	16.0	15.0	15.0	7.0	7.0	5.2	5.2	2.9	2.9	1.1	1.1	6.0-9.0
AG. Abalone	N/A	N/A	N/A	N/A	26.0	26.0	14.0	14.0	2.1	2.1	1.3	1.3	6.0-9.0

* Any facility located in population centers including but not limited to Anchorage, Cordova, Juneau, Ketchikan, Kodiak and Petersburg

** Any facility located in any area not defined as non-remote.

*** NSPS for oysters and scallops based on product; all other subcategories based on raw seafood.

Source: 44 FR 50740, August 29, 1979.

- Pollutants which create a fire or explosion hazard in the POTW.
- Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the works is specifically designed to accomodate such discharges.
- Solid or viscous pollutants in amounts which cause obstruction to the flow in sewers, or other interference with the operation of the POTW.
- Any pollutant, including oxygen demanding pollutants, released in a discharge or such volumne or strength as to cause interference in the POTW.
- Heat in amounts which will inhibit biological activity in the POTW resulting in interference but in no case heat in such quantities that the temperature at the treatment works influent exceed 40 C (104 F) unless the works is designed to accomadate such heat.

For all other subcategories of the seafood processing industry there are no limitations on BOD_5, TSS, pH, and Oil and Grease.

In cases where a seafood processing industry is not included in a subcategory, a Best Engineering Judgement (BEJ) is used to determine effluent limitations. These are established by an agreement between regional USEPA personnel and local administrators who incorporate the BEJ into the NPDES permit.

NPDES permits for new source industries may also impose special conditions beyond the effluent limitations stipulated, such as schedules of compliance and treatment standards. Once new source plants are constructed in conformance with all applicable standards of performance, they are relieved by Section 306(d) from meeting any more stringent standards of performance for 10 years or during the period of depreciation or amortization, whichever ends first (Section 306(d) applies only to new source NPDES permits, not all NPDES permits). However, this guarantee does not extend to toxic effluent standards adopted under Section 307(a), which can be added to the new source processing plant's NPDES permit when they are promulgated. These toxic effluent standards will be promulgated if the finding is that an industry's effluents contain more than trace amounts of the toxic compounds under investigation by USEPA. P.L. 95-217 also expands Section 307(a) of P.L. 92-500 dealing with toxic standards or prohibitions on existing sources. Thus, any evaluation of the impact of new or expanded seafood plants should include a verification on the status of applicable toxic effluent standards.

Many states have qualified, as permitted by P.L. 92-500, to administer their own NPDES permit programs. The major difference in obtaining an NPDES permit through approved state programs vis-a-vis the Federal NPDES permit program is that the Act does not extend the NEPA environmental impact assessment requirements to state programs. Because over half the States have enacted NEPA-type legislation, it is likely that new plants or major expansions of existing plants will come under increased environmental review in the future. Since the scope of the implementing regulations varies considerably, current information on prevailing requirements should be obtained early in the planning process from permitting authorities in the appropriate jurisdiction.

1.5.2 Air Pollution Control Regulations

The canned and preserved seafoods industry generally is not considered a major source of air pollutant emissions. Therefore, there are no national air pollution performance standards which apply to atmospheric emissions from these facilities. In the absence of Federal emission standards for the industry, air quality impacts are assessed based on ambient air quality standards, and applicable state and local standards.

National Ambient Air Quality Standards (NAAQS) (40 CFR 50) that specify the ambient air quality that must be maintained in the United States are shown in Table 8. Standards designated as primary are those necessary to protect the public health with an adequate margin of safety, and secondary standards are those necessary to protect the public welfare from any known or anticipated adverse effects of air pollution.

A combined Federal/state regulatory program is designed to achieve the objectives of the Clean Air Act and NAAQS. Each state must adopt and submit to USEPA a State Implementation Plan (SIP) for maintaining and enforcing primary and secondary air quality standards in Air Quality Control Regions. USEPA either approves the state's SIP or proposes and implements an alternate plan. The SIP's contain emission limits which may vary within a state due to local factors such as concentrations of industry and population. Because SIP's have been subject to frequent revision, it is best to verify the status of the SIP requirements before applying them.

Table 8. National primary and secondary ambient air quality standards (40 CFR Part 50).

	Type of Standard	Averaging Time	Frequency Parameter	Concentration	
				ug/m^3	ppm
Carbon monoxide	Primary	1 hr	Daily maximum[a]	40,110	35
		8 hr	Daily maximum[a]	10,310	9
Hydrocarbons	Primary and secondary	3 hr (6 to 9 a.m.)	Annual maximum[b]	160	0.24[c]
Nitrogen dioxide	Primary and secondary	1 yr	Arithmetic mean	100	0.05
Particulate matter[e]	Primary	24 hr	Annual maximum[b]	260	-
		24 hr.	Annual geometric mean	75	-
	Secondary	24 hr	Annual maximum[b]	150	-
		24 hr.	Annual geometric mean	60[d]	-
Sulfur dioxide	Primary	24 hr	Annual maximum[b]	365	0.14
		1 yr	Arithmetic mean	80	0.03
	Secondary	3 hr	Annual maximum[b]	1,300	0.5
Lead	Primary	90 day	Quarterly maximum[c]	1.5	-
Ozone	Primary and secondary	1 hr	Daily maximum[a]	235	0.12

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a. Expected exceedence less than or equal to one per year.

b. Not to be exceeded more than once per year.

c. As a guide in devising implementation plans for achieving oxidant standards.

d. As a guide to be used in assessing implementation plans for achieving the annual maximum 24-hour standard.

e. Not to be exceed more than once per 90 days.

Source: Adapted from 40 CFR Part 50, and 45 FR 55065.

There are two alternate programs requiring preconstruction approval of industrial air pollution abatement systems. These are the Prevention of Significant Deterioration (PSD) Program which applies to areas in compliance with NAAQS and the Nonattainment Program for areas which are in violation of NAAQS. In 1974, USEPA issued regulations for the PSD Program under the 1970 version of the Clean Air Act (P.L. 90-604). These regulations established a plan for protecting areas that possess air quality which is cleaner than the National Ambient Air Quality Standards. The PSD Program components include:

- Classification system for areas of the country meeting NAAQS.
- Limitations on the increase in concentration of pollutants above baseline conditions.
- Best Available Control Technology requirement for large sources.
- Preconstruction review and approval by permit of new source air pollution facility abatement programs.

Under USEPA's PSD regulatory plan, all areas of the nation are designated in one of three classes. The plan permits specified numerical increments of air pollution increases from major stationary sources for each class, up to a level considered to be significant for that area. Class I provides extraordinary protection from air quality deterioration and permits only minor increases in air pollution levels. Under this concept, virtually any increase in air pollution in these pristine areas is considered significant. Class II increments permit increases in air pollution levels that would accompany well-controlled growth. Class III increments permit increases in air pollution levels up to the NAAQS.

Sections 160 - 169 were added to the Act by the Clean Air Act Amendments of 1977. These Amendments adopted the basic concept of the above administratively developed procedure of allowing incremental increases in air pollutants by class. Through these Amendments, Congress also provided a mechanism to apply a practical adverse impact test which did not exist in the USEPA regulations previously.

The PSD requirements of 1974 apply only to two pollutants: total suspended particulates (TSP) and sulfur dioxide (SO_2). However, Section 166 requires USEPA to promulgate PSD regulations which address nitrogen oxides, hydrocarbons, lead, carbon monoxide, and photochemical oxidants, including use of increments or other effective control strategies which, if taken as a whole, accomplish the purposes of PSD policy set forth in Section 160.

The 1977 Amendments designate certain Federal lands as Class I, including all international parks, national memorial parks, national wilderness areas which exceed 5,000 acres, and national parks which exceed 6,000 acres. This constitutes 158 areas which may not be redesignated to another class through state or administrative action. The remaining areas of the country have been initially designated Class II. Within this Class II category, certain Federal lands over 10,000 acres (national primitive areas, national wild and scenic rivers, national wildlife refuges, national seashores and lakeshores, and new national park and wilderness areas) established after 7 August 1977 will be Class II "floor areas" ineligible for redesignation to Class III.

The general redesignation responsibility lies with the states. The Federal land manager has an advisory role for redesignation to the appropriate state and to Congress. Redesignation by Congress will require the normal legislative process of committee hearings, floor debate, and action. In order for a state to redesignate areas, the detailed process (outlined in Section 164(b) of the 1977 Amendments) would include an analysis of the health, environmental, economic, social, and energy effects of the proposed redesignation which would be discussed at a public hearing.

In theory, all new source canned and preserved seafoods facilities would be subject to a complete PSD review if they obtain their air quality permits after March 1, 1978, or have potential (before control) emissions in excess of 250 tons/year of certain pollutants. Full PSD review requires analysis of effect on air quality increments, application of Best Available Technology, and a comprehensive monitoring program. In practice, however, small sources of the designated air pollutants (less than 50 tons/year, 1,000 lbs/day, or 100 lbs/hour after abatement) are required only to apply for and obtain a preconstruction permit unless they would impact a Class I area. Therefore most new source plants should not have to go through the full PSD review. A similar type of exemption exists for small sources (less than 50 tons/year after abatement) in non-attainment areas unless the pollutant emitted is the cause for non-attainment. In that case, a permit would be issued only after controls (offsets) were obtained by the new source from existing emission sources sufficient to affect a net reduction of the non-attainment pollutant.

1.5.3 Solid Waste Disposal Regulations

The applicability of the Resource Conservation and Recovery Act (RCRA) to the seafood processing industry would be minimal as most wastes from a plant are highly biodegradable. The seafood processing industry itself is not regulated under Section C of RCRA. However, any wastes associated with power generation facilities, particularly waste oils from diesel power generation plants, would be covered. Waste product solids, ash from power generation, and trash would be subject to the sections of RCRA dealing with non-hazardous solid wastes. In general, recovery or disposal in a sanitary landfill will be required under a state regulatory program. New open dumps will be prohibited. Existing state regulatory requirements for solid waste disposal that do not meet or exceed the new Federal requirements will be superseded. Types of land disposal that are available to meet the industry needs are discussed in Chapter 3.0.

1.5.4 Other Regulations

The applicant should be aware that there may be a number of regulations other than pollution control regulations that have some application to the siting and operation of seafood processing plants. The applicant should place special emphasis in the identification of other applicable regulations that might apply to the proposed new source. Federal statutes and regulations that may be pertinent to a proposed facility are:

Fisheries Resource Conservation Act of 1976 (P.L. 94-265)
Coastal Zone Management Act of 1972
The Fish and Wildlife Coordination Act
The Marine Protection, Research, and Sanctuaries Act of 1972
The National Environmental Policy Act of 1969

The Rivers and Harbors Act of 1899
USDA Agriculture Conservation Service Watershed Memorandum 198 (1971)
Food, Drug and Cosmetic Act, as amended
Wild and Scenic Rivers Act of 1969
The Flood Control Act of 1944
Federal-Aid Highway Act, as amended (1970)
The Wilderness Act (1964)
Endangered Species Preservation Act, as amended (1966)
The National Historical Preservation Act of 1974
Executive Orders 11593, 11988, and 11990
Archaeological and Historic Preservation Act of 1974
Procedures of the Council on Historic Preservation (1973)
Occupational Safety and Health Act of 1970

In connection with these regulations, the applicant should place particular emphasis on the possibilities of disturbing an archaeological site, such as an early Indian settlement or a prehistoric site. The applicant should first consult with the State Historic Preservation Officer (SHPO) and the National Register of Historic Places. If the SHPO states that there is no need for a survey, no archaeologist needs to be hired, whereas a survey may be required if archaeological sites might be affected by the proposed plant. The applicant should also consult the appropriate wildlife agency (state and Federal) to ascertain that the natural habitat of a threatened or endangered species will not be adversely affected.

From a health and safety standpoint, all complex industrial operations involve a variety of potential hazards, and to the extent that these hazards could affect the health of plant employees they may be characterized as potential environmental impacts. These hazards exist in seafood processing plants because of the very nature of the operation--for example, the use of water under conditions of high temperatures and pressure, or the operation of mechanical butchering equipment--and all plant owners should emphasize that no phase of operation or administration is of greater importance than safety and accident prevention. Company policy should provide and maintain safe and healthful conditions for its employees and establish operating practices that will result in safe working conditions and efficient operation.

The plant must be designed and operated in compliance with the standards of the US Department of Labor, the Occupational Safety and Health Administration, and the appropriate state statutes relative to industrial safety. The applicant also should coordinate closely with local or regional planning and zoning commissions to determine possible building or land use limitations.

2.0 IMPACT IDENTIFICATION

2.1 PROCESS WASTES

This subsection covers the generation of liquid effluents, air emissions, and solid wastes. These data were developed mainly in support of the effluent limitations development program for the USEPA. These represent the best general information on all aspects of the seafood processing industry. The information is useful in the characterization of the general level of waste generation expected for such facilities.

2.1.1 Air Emissions

Seafood processing is generally the handling of a wet raw material that is processed in the wet condition. With the exception of fish meal production, the point source emissions from the industry are very minor. Fishmealing may generate air-borne pollutants from the following sources:

- Mealing operation where fish meal dust and volatile oils are entrained in the drying air.
- Evaporators used to concentrate the solubles.

Odor generation is a problem due to the putrescible nature of the materials handled. Odor may be associated either with the wastewater streams or the solid waste streams.

2.1.2 Water Discharges

Water discharges from the seafoods processing industry generally contain pollutants that are highly biodegradable, reflecting the residue from the processing of animal bodies. The major parameters of interest are biochemical oxygen demand (BOD), total suspended solids (TSS), and oil and grease.

BOD generally comes from dissolved blood, body fluids, pieces of meat, body slimes, and detergents from cleaning operations. TSS generally consist of shell, bone, skins, scales, meat, and dirt from floors and product. Oil and grease is generated by animal fats which escape during cooking, rendering, and processing. These natural oils are highly biodegradable. The discharges may contain ground-up crab shells, which are not highly biodegradable.

The waste loading from the industry has been estimated in several reports prepared for the USEPA program to establish effluent guidelines (USEPA 1974a, USEPA 1975c, E.C. Jordan 1979). For a new source industry, the recent emphasis on wastewater treatment will have an impact on the selection and design of the process equipment. Therefore, it is likely that data collected even during the mid-1970's would tend to overestimate the waste generation for a new seafood processing facility. Such considerations were included in a recent analysis of the data collected for the original effluent guidelines documents. The conclusions of that analysis are summarized in Table 9, which shows the flow and pollutants expected for an average facility in all industry subcategories with three exceptions. These are Subcategory T (Alaskan bottomfish), Subcategory AC (Alaskan scallop), and Subcategory AD (non-Alaskan scallop), for which there were insufficient data to perform a detailed reevaluation. Tables 10 through 23 summarize the reported pollutant and flow estimates for industry subcategories. The data for Table 9 and for Tables 10 through 23 are from different references, so there is not an exact agreement between the averages for each subcategory. However, these estimates are useful in the identification of a reasonable range for flow and pollutant generation.

The following sections describe the data on pollutant generation for each subcategory, providing additional information on source and quantity. The general sources for these data are the original studies by USEPA. The data were obtained as follows: first, a preliminary segmentation was conducted and the relative importance of these segments estimated; second, a representative number of plants in each segment was sampled; and third, the results of the field work were analyzed and final subcategories established. The data from typical plants belonging to each subcategory were then averaged to obtain an estimate of the characteristics of that subcategory (typical raw waste loads).

2.1.2.1 Catfish Processing

Wastes from catfish processing generally include blood, slime, skins, and particles of flesh and feces from the holding tanks, skinning machines, and

Table 9. Baseline waste loads for seafood processing industry subcategories.

Subcategory	Flow		BOD$_5$	TSS	O & G	Note
	(l/kkg)	(gal/ton)	(kg/kkg)	(kg/kkg)	(kg/kkg)	
A. Farm Raised Catfish	14,100	3,380	5.65	6.22	3.55	-
B. Conventional Blue Crab	1,100	264	–	0.784	0.229	-
C. Mechanized Blue Crab	31,400	7,530	-	11.6	4.66	-
D,E. Alaskan Crab Meat	44,800	10,700	-	5.63	0.798	1
F,G. Alaskan Whole Crab and Crab Section	20,200	4,850	-	1.86	0.452	1
H. Dungeness and Tanner Crab	19,900	4,770	-	3.47	0.965	-
I,J. Alaskan Shrimp	90,600	21,800	-	97.5	20.0	1
K. Northern Shrimp	51,900	12,400	-	41.5	19.0	-
L. Southern Non-Breaded Shrimp	44,500	10,700	-	27.3	6.24	-
M. Breaded Shrimp	98,200	23,500	-	49.2	1.84	-
N. Tuna	11,200	2,680	-	7.66	4.46	2
O. Fish Meal (with solubles)	17,400	4,160	3.08	1.16	0.623	1
O. Fish Meal (without solubles)	12,900	3,100	50.2	28.3	16.2	1
P,R. Hand-Butchered Salmon	3,420	818	-	0.787	0.146	-
Q,S. Mechanized Salmon	14,200	3,400	-	17.1	5.67*	3
T. Alaskan Bottomfish			-	-	-	4

Table 9. Baseline waste loads for seafood processing industry subcategories (cont.).

Subcategory	Flow (l/kkg)	Flow (gal/ton)	BOD_5 (kg/kkg)	TSS (kg/kkg)	O & G (kg/kkg)	Note
U. Non-Alaskan Bottomfish, Manual	3,980	955	-	1.30	0.378	-
V. Non-Alaskan Bottomfish, Mechanized	12,800	3,080	-	8.77	2.75	1
W. Hand-shucked Clam	4,840	1,160	-	4.94	0.104	1
X. Mechanized Clam	8,100	1,940	-	3.83	0.441	-
Y. Pacific Coast Hand-shucked Oyster	34,700	8,340	-	19.4	1.35	5
Z. East & Gulf Coast Hand-Shucked Oyster	29,000	6,980	-	12.4	0.603	5
AA. Steamed and Canned Oyster	69,300	16,600	-	138	1.29	1,5
AB. Sardine	6,950	1,670	-	4.47	2.30	-
AC, AD. Scallop			-	-	-	4
AE, AF. Herring Fillet	12,500	2,900	-	13.2	3.77	1
AG. Abalone	34,100	8,190	-	9.45	0.975	-

Notes (Waste loads based on raw seafood except as noted)

1. Value adjusted to assure all baseline levels have been achieved by the same plant.
2. Flow ratio is achievable with a thaw recycle system.
3. Waste load is achievable without the use of head cooker or by eliminating this waste stream from the plant effluent.
4. Insufficient data to characterize subcategory.
5. Waste loads are based on production in terms of finished product.

Source: Edward C. Jordan, Inc. 1979.

Table 10. Catfish process material balance and wastewater characteristics (Subcategory A).

I. Wastewater-Material Balance Summary

Catfish (Subcategory A): Average Flow = 116 cu m/day (0.0306 mgd)

Unit Operation	% Flow(Avg)	% Range
a) live holding tanks	59	55 - 64
b) butchering (beheading, eviscerating)	--	--
c) skinning	4	2 - 7
d) cleaning	14	9 - 18
e) packing (including sorting)	3	1 - 5
f) cleanup	7	5 - 9
g) washdown flows	13	9 - 16

II. Product - Material Balance Summary

Catfish (Subcategory A): Avg. Raw Product Input = 5.19 kkg/day (5.72 ton/day)

Output	% of Raw Product	Range %
Food Product	63	--
By-product	27	0 - 32
Waste	10	5 - 37

III. Wastewater Characteristics

	Subcategory A	
Parameter	Mean	Range
Flow, liters/kkg	23,000	15,800 to 31,500
gal/1,000 lbs	2,755	1,890 to 3,775
BOD$_5$*	7.9	5.5 to 9.2
Total Suspended Solids*	9.2	6.8 to 12.0
Oil and Grease*	4.5	3.8 to 5.6
pH	6.3	5.8 to 7.0

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* kg of parameter/kkg of raw seafood (or lb/1,000 lbs)

Source: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp and tuna segment of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

processing lines. Table 10 shows the process material balance and wastewater characteristics for this subcategory.

2.1.2.2 Blue Crab Processing

Blue crab processing generates the same pollutants for both mechanized and manual systems. The waste load per unit of process is much lower for the conventional process, but the mechanized process uses more water and therefore has lower strength wastewater (e.g., BOD_5 from hand-picked crab may be 4,410 mg/l and mechanical, 650 mg/l). BOD is from the blood, body fluids, bits of meat, shell, and cleaning detergents. Suspended solids are from bits of meat, shell, and grit from cleaning. Oils and grease generally are released from crab during the cooking process. Table 11 presents the mass balances and the wastewater characteristics for these subcategories, where the difference in pollution generation is evident.

2.1.2.3 Alaskan Crab Processing

Alaskan crab processing waste characteristics are the same at remote and non-remote plant locations. The BOD is generally from blood, body fluids, meat, shell, and clean-up detergents. Suspended solids generally come from bits of meat, shell, and grit from cleanup. Oil and grease are released from the meat during the cooking process. The wastes (excluding shell) are highly biodegradable. The waste characteristics for the whole cook and crab section subcategory are the same. Wastewater flows are much lower in the whole and section process as the quantities of water needed to remove shell and wash the meat are much lower. Table 12 presents the mass balances and wastewater characteristics for these subcategories. The lesser mechanized subcategory, whole and section crab, has the lower waste flow per unit of production.

2.1.2.4 Dungeness and Tanner Crab Processing

Dungeness and tanner crab processing generates a wastewater with characteristics similar to that of Alaskan crab meat processing. Table 13 presents the mass balance and wastewater characteristics for facilities in this subcategory. Oil and grease were not measured during the study of the wastewater

Table 11. Conventional and mechanical blue crab processes material balances and wastewater characteristics (Subcategories B,C).

I. Wastewater-Material Balance Summary

Blue crab, conventional (Subcategory B):
Average flow = 2.52 cu m/day (665 gpd)

Unit Operation	% Flow (Avg)	% Range
a) washdown	23	17 - 26
b) cook	17	13 - 21
c) ice	60	-

Blue Crab, mechanical (Subcategory C):
Average flow = 176 cu m/day
(0.9465 mgd)

Unit Operation	% Flow (Avg)	% Range
a) machine picking	90.5	-
b) brine tank	0.5	-
c) washdown	7.7	-
d) cook	0.2	-
e) ice making	1.1	-

II. Product-Material Balance Summary

Blue crab, conventional (Subcategory B):
Avg. Raw Product Input = 2.59 kkg/day (2.85 ton/day)

Blue crab, mechanical (Subcategory C):
Avg. Raw Product Input = 4.8 kkg/day (5.3 ton/day)

	Subcategory B		Subcategory C	
Output	% of Raw Product	Range %	% of Raw Product	Range %
Food product	14	9 - 16	14	9 - 16
By-product	80	79 - 86	80	79 - 86
Waste	6	-	6	-

Table 11. Conventional and mechanical blue crab processes material balances and wastewater characteristics (Subcategories B,C) (continued).

III. Wastewater Characteristics

	Subcategory B		Subcategory C	
Parameter	Mean	Range	Mean	Range
Flow, l/kkg	1,190	1,060 to 1,310	36,800	29,000 to 44,600
gal/1,000 lbs	143	128 to 158	4,415	3,480 to 5,350
BOD$_5$*	5.2	4.8 to 5.5	22.0	22.0 to 23.0
TSS*	0.74	0.7 to 0.78	12.0	7.9 to 16.0
Oil and Grease*	0.26	0.21 to 0.30	5.6	4.3 to 6.9
pH	7.5	7.2 to 7.9	7.0	6.9 to 7.2

---

* Ratios remain the same for kg of parameter/kkg raw seafood (or lb/1,000 lbs)

Source: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp and tuna segment of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

Table 12. Alaska crab frozen and canned meat processes (with waste grinding) and whole crab and crab sections processes material balances and wastewater characteristics (Subcategories D,E,F,G).

I. Wastewater-Material Balance Summary

Alaska crab, frozen and canned (Subcategories D and E):
Average Flow = 440 cu m/day (0.116 mgd)

Unit Operation	% Flow (Avg)	% Range
a) butcher and grinding	30	25 - 45
b) precook and cook	3	1 - 5
c) cool	6	2 - 9
d) meat extraction	34	30 - 40
e) sort, pack, freeze	7	5 - 10
f) retort	10	5 - 15
g) cleanup	10	8 - 15

Alaska crab, whole and sections (Subcategories F and G):
Average Flow = 364 cu m/day (0.096 mgd)

Unit Operation	% Flow (Avg)	% Range
a) butcher and grinding	26	15 - 40
b) precook and cook	19	15 - 25
c) wash and cool	36	20 - 50
d) sort, pack, freeze	9	5 - 12
e) cleanup	10	15 - 20

II. Product-Material Balance Summary

Alaska crab, frozen and canned (Subcategories D and E):
Average Raw Product Input Rate = 8.40 kkg/day (9.25 tons/day)

Alaska crab, whole and sections (Subcategories F and G):
Average Raw Product Input Rate = 13.06 kkg/day (14.40 tons/day)

	Subcategories D and E		Subcategories F and G	
Output	% of Raw Product	Range %	% of Raw Product	Range %
Food product	14	10 - 20	64	57 - 69
By-product	66	50 - 75	21	15 - 30
Waste	20	10 - 30	15	10 - 30

Table 12. Alaska crab frozen and canned meat processes (with waste grinding) and whole crab and crab sections processes material balances and wastewater characteristics (Subcategories D,E,F,G.) (continued).

III. Wastewater Characteristics

	Subcategories D and E		Subcategories F and G	
Parameter	Mean	Range	Mean	Range
Flow, 1/kkg	51,700	32,800 to 85,500	30,758	28,025 to 32,396
gal/1,000 lbs	6,200	3,935 to 10,25	3,676	3,350 to 3,877
BOD_5*	22.0	8.0 to 28	3.4	2.4 to 4.8
TSS*	7.0	2.0 to 9	2.1	0.6 to 4.8
Oil and Grease*	3.0	0.2 to 5	0.3	0.2 to 0.4
pH	7.5	7.4 to 7.7	7.6	7.4 to 8.2

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* Ratios remain the same for kg of parameter/kkg of raw seafood (or lb/1,000 lbs)

Source: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp and tuna segment of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

Table 13. Dungeness crab and tanner crab process (without fluming wastes) in the contiguous United States material balance and wastewater characteristics (Subcategory H).

I. Wastewater-Material Balance Summary

Dungeness and tanner crab (Subcategory H):
Average Flow = 95 cu m/day (0.025 mgd)

Unit Operation	% Flow (Avg)	% Range
a) butcher (clean-up)	8	4 - 11
b) bleed rinse	25	12 - 30
c) cook	3	2 - 4
d) cool	30	26 - 33
e) pick (clean-up)	7	5 - 8
f) brine and rinse	27	18 - 34

II. Product-Material Balance Summary

Dungeness and tanner crab (Subcategory H):
Average Raw Product Input Rate = 6.3 kkg/day (7.0 tons/day)

Output	% of Raw Product	Range %
Food product	22	17 - 27
By-product	63	50 - 66
Waste	15	7 - 23

III. Wastewater Characteristics

	Subcategory H	
Parameter	Mean	Range
Flow, l/kkg	19,000	14,800 to 21,300
gal/1,000 lb	2,280	1,780 to 2,550
BOD_5*	8.1	6.6 to 11.0
TSS*	2.7	2.6 to 2.9
Oil and Grease*	Not measured	- -
pH	7.4	7.3 to 7.7

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* Ratios remain the same for kg of parameter/kkg of raw seafood (or lb/1,000 lb)

Source: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp and tuna segment of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

characteristics; however, the ranges probably are similar to the reported data for Alaskan crab meat processing.

2.1.2.5 Alaskan and Northern Shrimp Processing

Alaskan shrimp and northern shrimp processing wastes are the same for both remote and non-remote plants. The wastes are biodegradable with the sources of BOD including the shell, meat, blood, body fluids, and cleaning agents. The suspended solids come from shell, head, bits of meat, and grit from cleanup and the shrimp. Oil and grease is released from the shrimp during pre-cooking and mechanical peeling. Table 14 presents data for facilities in these subcategories.

2.1.2.6 Southern Non-breaded Shrimp Processing

The southern non-breaded shrimp subcategory generates wastewater with characteristics similar to those for the Alaskan and northern shrimp industry. Because most southern shrimp are beheaded at sea, the waste quantity per unit of product is much less than for northern shrimp. Table 15 presents the mass diagram and wastewater characteristics for facilities in this subcategory.

2.1.2.7 Breaded Shrimp Processing

The majority of the plants which bread shrimp are located in the southern states. Waste characteristics are generally the same as for non-breaded shrimp processing, except for higher BOD and suspended solids concentrations from the breading operation, where overflow water, machine and vat washing, and reclamation of poorly breaded product greatly increase flows and strengths. Oil and grease data are not reported from the development document preparation, but should be in the ranges for the conventional shrimp processing subcategories. Table 15 presents the mass balance and wastewater characteristics for the breaded shrimp subcategory.

Table 14. Alaskan and northern shrimp processes material balances and wastewater characteristics (Subcategories I,J,K).

I. Wastewater-Material Balance Summary

Alaskan and northern shrimp (Subcategories I,J,K):
Average Flow = 1,170 cu m/day (0.310 mgd)

Unit Operation	% Flow (Avg)	% Range
a) fish picking and ageing	4	0 - 5
b) peelers	45	40 - 50
c) washers and separators	15	10 - 30
d) blanchers	2	1 - 5
e) meat flume	19	10 - 20
f) retort and cool	5	3 - 8
g) cleanup	10	5 - 15

II. Product-Material Balance Summary

Alaskan and northern shrimp (Subcategories I,J,K):
Average Raw Product Input Rate = 13.9 kkg/day (15.30 tons/day)

Output	% of Raw Product	% Range
Food product	15	13 - 18
By-product	65	50 - 80
Waste	20	15 - 40

III. Wastewater Characteristics

	Subcategories I,J,K	
Parameter	Mean	Range
Flow, l/kkg	73,400	60,000 to 192,500
gal/1,000 lbs	8,800	7,200 to 23,000
BOD$_5$*	130.0	27.0 to 182.0
TSS*	210.0	64.0 to 336.0
Oil and Grease*	17.0	4.5 to 48.0
pH	7.7	7.4 to 8.5

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* Ratios remain the same for kg of parameter/kkg of raw seafood (or lb/1,000 lb)

Source: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp and tuna segment of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

Table 15. Southern non-breaded and breaded shrimp processes material balances and wastewater characteristics (Subcategories L,M).

I. Wastewater-Material Balance Summary

Southern non-breaded shrimp (Subcategory L):
Average Flow = 787 cu m/day (0.208 mgd)

Unit Operation	% Flow (Avg)	% Range
a) peelers (Model A)	58	42 - 73
b) washers	9	8 - 10
c) separators	7	5 - 9
d) blancher	2	0.006 - 2
e) de-icing	4	0.005 - 7
f) cooling and retort	12	8 - 20
g) washdown	8	7 - 10

Breaded southern shrimp (Subcategory M):
Average Flow = 653 cu m/day (0.172 mgd)

Unit Operation	% Flow(Avg)	% Range
a) hand peeling	5	3 - 7
b) thawing or de-icing	4	2 - 7
c) breading area	2	1 - 3
d) washdown	51	29 - 73
e) automatic peelers	38	34 - 55

II. Product-Material Balance Summary

Southern non-breaded shrimp (Subcategory L):
Average Raw Product Input Rate = 23.9 kkg/day (26.4 tons/day)

Southern breaded shrimp (Subcategory M):
Average Raw Product Input Rate = 6.3 kkg/day (7.0 tons/day)

	Subcategory L		Subcategory M	
Output	% of Raw Product	% Range	% of Raw Product	% Range
Food Product	20	15 - 25	80	75 - 85
By-product	65	58 - 71	15	10 - 20
Waste	15	13 - 18	5	3 - 6

Table 15. Southern non-breaded and breaded shrimp processes material balances and wastewater characteristics (Subcategories L,M) (continued).

III. Wastewater Characteristics

	Subcategory L		Subcategory M	
Parameter	Mean	Range	Mean	Range
Flow, l/kkg	47,200	33,000 to 58,400	116,000	108,000 to 124,000
gal/1,000 lbs	5,600	3,950 to 7,000	13,950	13,000 to 1,490
BOD_5*	46.0	41.0 to 51.0	84.0	81.0 to 87
TSS*	38.0	16.0 to 50.0	93.0	76.0 to 110
Oil and Grease*	12.0	5.4 to 36.0	--	-- --
pH	6.7	6.5 to 7.0	7.8	7.7 to 7.9

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* Ratios remain the same for kg of parameter/kkg of raw seafood (or lb/1,000 lbs)

Source: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standard for the catfish, crab, shrimp and tuna segment of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

2.1.2.8 Tuna Processing

Tuna processing wastes are composed of blood, body fluids, skin, slime, bone, and bits of meats. These are highly biodegradable and the primary source for BOD, which also includes the demand from cleaning solutions. Suspended solids are derived from bits of meat, bone, skin, and gut from cleaning operations. Oil and grease is released during the cooking of the tuna. Table 16 presents the mass balance and wastewater characteristics for tuna processing.

2.1.2.9 Fish Meal Processing

Fish meal plant wastes are derived from the stickwater, the bailwater, the evaporators, air scrubbers, and the plant washdown waters. The wastes are highly biodegradable and unstable as they are slimes, fish particles, body fluids, and cleaning agents. Unless the pH is kept low (i.e., acidic), the stickwater (a broth consisting of body fluids and steam condensate) will become putrescible within several days. Table 17 presents the mass balance for a facility with a solubles plant and for a facility without a solubles plant. Suspended solids in the wastewater are generated from the bits of meat and scales which pass through the presses or are entrained in the air scrubbers. Oil and grease is extracted from the body during the cooking and rendering process.

2.1.2.10 Salmon Processing

Salmon processing wastes mainly are derived from bailing water, the butchering process, and plant cleanup. During the butchering process (whether mechanical or manual), the heads, tails, viscera, blood, and fins are removed and the fish completely cleaned for food processing. The BOD is derived from all of these wastes plus those added by cleaning materials. The suspended solids in the waste stream consist of scales and bits of flesh and gut from plant cleanup and fish washing. Oil and grease is generated from the body fluids released during the butchering and sliming process. Table 18 presents the mass balances for hand-butchered, mechanical butchered, and fresh/frozen round salmon, respectively.

Table 16. Tuna process material balance and wastewater characteristics (Subcategory N).

I. Wastewater-Material Balance Summary

Tuna (Subcategory N):
Average Flow = 3,060 cu m/day (0.81 mgd)

Unit Operation	% Flow (Avg)	% Range
a) thaw	65	35 - 75
b) butcher	10	5 - 15
c) pak-shaper	2	1 - 3
d) can washer	2	1 - 3
e) retort	13	6 - 19
f) washdown	7	5 - 10
g) miscellaneous	1	0 - 2

II. Product-Material Balance Summary

Tuna (Subcategory N):
Average Raw Product Input Rate = 167 kkg/day (184 tons/day)

Output	% of Raw Product	% Range
Food Product	45	40 - 50
By-products		
Viscera	12	10 - 15
Head, skin, fins, bond	33	30 - 40
Red meat	9	8 - 10
Waste	1	0.1 - 2

III. Wastewater Characteristics

	Subcategory N	
Parameter	Mean	Range
Flow, l/kkg	18,300	5,590 to 33,000
gal/1,000 lbs	2,200	670 to 3,960
BOD$_5$*	13.0	6.8 to 20.0
TSS*	10.0	3.8 to 17.0
Oil and Grease*	5.8	3.2 to 13.0
pH	6.7	6.2 to 7.2

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* Ratios remain the same for kg of parameter/kkg of raw seafood (or lb/1,000 lbs)

Source: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp and point source category. EPA-440/1-74-020. Washington DC.

Table 17. Fish meal production with solubles plant and without solubles plant processes material balances (Subcategory O).

I. Wastewater-Material Balance Summary

Fish meal, with soluble (Subcategory O):
Average Flow = 27,540 cu m/day (7.27 mgd)

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) evaporator	80 - 85	60 - 85	60 - 90
b) air scrubber	15 - 20	15 - 40	10 - 40
Total effluent average*	51,000 l/kkg	3.7 kg/kkg	1.6 kg/kkg

Fish meal, without solubles (Subcategory O):
Average Flow = 350 cu m/day (0.092 mgd)

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) stickwater	45	93	94
b) bailwater	39	7	6
c) washdown	1	1	1
d) air scrubber	15	1	1
Total effluent average*	1,870 l/kkg	71 kg/kkg	59 kg/kkg

II. Product-Material Balance Summary

Fish meal, with solubles (Subcategory O):
Average Production Rate = 540 kkg/day (600 tons/day)

Fish meal, without solubles (Subcategory O):
Average Production Rate = 187 kkg/day (207 tons/day)

End Products	% of Raw Product (with solubles)	% of Raw Product (without solubles)
Products		
a) meal	6 - 8	28
b) oil	20 - 21	8
Byproducts		
a) solubles	15	-
Wastes		
a) stickwater	-	35
b) water vapor	-	29
c) water	56 - 59	-

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* Based on kkg of raw seafood

Table 17. Fish meal production with solubles plant and without solubles plant processes material balances (Subcategory O) (cont.).

Source: US Environmental Protection Agency. 1975d. Development document for interim final effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, sardine, herring, clam, oyster, scallop and abalone segment of the canned and preserved seafood processing point source category phase II. EPA-440/1-74-041. Washington DC.

Table 18. Salmon processes material balances (hand-butchered, mechanical-butchered, and fresh/frozen) (Subcategories P,Q,R,S,).

I. Wastewater-Material Balance Summary

Salmon, hand-butchered (Subcategories P and R):

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) butchering line	20	24	17
b) fish cutter	20	16	17
c) can filler	5	21	30
d) can washer	22	5	5
e) washdown	33	34	30
Total effluent average*	5,400 l/kkg	3.4 kg/kkg	2.0 kg/kkg

Salmon, mechanical butchered (Subcategories Q and S):

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) unloading water	12	10	7
b) iron chink	27	65	56
c) fish scrubber	19	5	3
d) sliming table	13	6	18
e) fish cutter	7	4	5
f) can washer and clincher	2	1	1
g) washdown	20	10	11
Total effluent average*	19,800 l/kkg	45.5 kg/kkg	24.5 kg/kkg

Salmon, fresh/frozen

Unit Operation	% Flow(Avg)	% of Total BOD	% of Total Susp. Solids
a) process water	88 - 96	76 - 92	74 - 97
b) washdown	4 - 12	8 - 24	3 - 26
Total effluent average*	3,750 l/kkg	2 kg/kkg	0.8 kg/kkg

Table 18. Salmon processes material balances (hand-butchered, mechanical-butchered, and fresh/frozen) (Subcategories P,Q,R,S) (continued).

II. Product-Material Balance Summary

Salmon, hand-butchered (Subcategories P and R):
Average Production Rate = 4.8 kkg/day (5.3 tons/day)

No data available

Salmon, mechanical-butchered (Subcategories Q and S):
Average Production Rate = 37 kkg/day (41 tons/day)

End Products	% of Raw Product
Food products	62 - 68
By-product	
a) roe	4 - 6
b) milt	2 - 3
c) oil	1
d) heads	12 - 14
e) viscera	0 - 5
Wastes	11 - 16

Salmon, fresh/frozen:
Average Production Rate = 16.4 kkg/day (18 tons/day)

End Products	% of Raw Product
Food products	
a) salmon	65 - 80
b) eggs	5
c) milk	3
By-product	
a) heads	8
b) viscera	5 - 7
Waste	1 - 2

---

* Based on kkg of raw seafood

Source: US Environmental Protection Agency. 1975d. Development document for interim final effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, sardine, herring, clam, oyster, scallop and abalone segment of the canned and preserved seafood processing point source category phase II. EPA-440/1-74-041. Washington DC.

2.1.2.11 Bottomfish Processing

Bottomfish processing wastes are very similar in source and biodegradability to those of the salmon processing industry, regardless of species processing or plant location. One difference is that some bottomfish are skinned and filleted, whereas salmon are rarely filleted and skinned at the plant. The source of BOD includes: slime, blood, body fluids, heads, fins, bits of meat, and cleaning agents. The components of the suspended solids are fish scales, viscera, fins, heads, bits of meat, and gut from fish washing and plant cleanup. Oil and grease is from the oils in the body fluids that are released during processing. Table 19 presents mass balances for several process configurations.

2.1.2.12 Herring and Sardine Processing

The waste characteristics of the herring filleting and sardine canning industry are very nearly the same as for the salmon and bottomfish processing plants. Because large herring and sardines (small herring) are oily fish, larger amounts of oil and grease are generated than during bottomfish processing. The source of the BOD for sardine processing is from blood and debris in the bailwater, body liquids from the holding tanks, slime and body fluids from the packing, stickwater from pre-cooking, and oils and cleaners from can washing. The suspended solids come from debris, fish pieces, scales, fins, and heads from the bailing and butchering of the sardines. Oil and grease generally is from the oils released during the cooking and decanting of the sardine cans and from can washing. Table 20 presents the material balance for sardine processing plants.

BOD from herring filleting is from the body fluids, blood, fish portions, and cleaning materials. The suspended solids are mainly from scales, heads, fins, bones, and meat scraps from bailing, the holding bins, and processing lines. If roe and milt are being packed, there are solids from this process also. Oil and grease are generated during holding and processing. Table 20 also presents the material balance for herring filleting plants.

Table 19. Alaskan bottomfish freezing, non-Alaskan bottomfish, manual and mechanized, and non-Alaskan bottomfish freezing processes material balances (Subcategories T,U,V).

I. Wastewater-Material Balance Summary

Alaskan bottomfish, freezing (Subcategory T):

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) head cutter/grader	3	11	10
b) washer	79	72	62
c) washdown	18	17	28
Total effluent average*	8,600 l/kkg	1.5 kg/kkg	1.2 kg/kkg

Non-Alaskan bottomfish, manual (Subcategory U):

Unit Operation	% Flow(Avg)	% of Total BOD	% of Total Susp. Solids
a) skinner	13 - 64	6 - 36	5 - 39
b) fillet table	22 - 83	43 - 76	39 - 80
c) pre-rinse or dip tank	1 - 13	7 - 26	5 - 34
d) washdown	3 - 21	4 - 20	7 - 21
Total effluent average*	8,000 l/kkg	2.8 kg/kkg	1.8 kg/kkg

Non-Alaskan bottomfish, mechanized (Subcategory V):

Unit Operation	% Flow(Avg)	% of Total BOD	% of Total Susp. Solids
a) descaler	42 - 66	56 - 61	26 - 70
b) fillet table	21 - 36	16 - 30	12 - 19
c) pre-wash or dip tank	3 - 10	4 - 8	4 - 8
d) washdown	7 - 18	6 - 19	7 - 18
Total effluent average*	10,000 l/kkg	2.5 kg/kkg	1.6 kg/kkg

Non-Alaskan bottomfish, freezing (Subcategory V):

Unit Operation	% Flow(Avg)	% of Total BOD	% of Total Susp. Solids
a) process water	70 - 75	74 - 77	74 - 78
b) washdown	3 - 8	2 - 5	2 - 6
c) visceral flume	22	21	20
Total effluent average*	13,500 l/kkg	14 kg/kkg	11 kg/kkg

Table 19. Alaskan bottomfish freezing, non-Alaskan bottomfish, manual and mechanized, and non-Alaskan bottomfish freezing processes material balances (Subcategories T,U,V) (continued).

II. Product-Material Balance Summary

Alaskan bottomfish, freezing (Subcategory T):
Average Production Rate = 33 kkg/day (36 tons/day)

End Products	% of Raw Product
Food products	90
By-products a) heads	10
Wastes	minimal

Non-Alaskan bottomfish, manual (Subcategory U):
Average Production Rate = 16.5 kkg/day (18 tons/day)

End Products	% of Raw Product
Food products	20 - 40
By-products a) carcass (reduction, animal food)	55 - 75

Non-Alaskan bottomfish, freezing (Subcategory V):
Average Production Rate = 35 kkg/day (38 tons/day)

End Products	% of Raw Product
Food Products	50
By-product a) heads, scales, viscera (to reduction plant)	48
Waste	2

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* Based on kkg of raw seafood

Source: US Environmental Protection Agency. 1975d. Development document for interim final effluent limitations guidelines and proposed new source performance standards for the fish meal, salmon, bottomfish, sardine, herring, clam, oyster, scallop and abalone segment of the canned and preserved seafood processing point source category, phase II. EPA-440/1-74-041. Washington DC.

Table 20. Sardine canning and herring filleting processes material balances (Subcategories AB, AE, AF).

I. Wastewater-Material Balance Summary

Sardine canning (Subcategory AB):

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) flume (boat to storage)	14 - 46	12 - 28	11 - 57
b) flume (brine tank to table)	18 - 62	14 - 22	16 - 30
c) pre-cook can dump	1 - 4	28 - 67	14 - 51
d) can wash	3 - 4	16 - 23	9 - 10
e) retort	8 - 53	1 - 2	1 - 4
f) washdown	1 - 10	1 - 6	1 - 12
Total effluent average*	7,600 l/kkg	10 kg/kkg	7 kg/kkg

Herring filleting (Subcategories AE,AF):

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) process water	58	70	59
b) bailwater	37	27	38
c) washdown	5	3	3
Total effluent average*	10,200 l/kkg	34 kg/kkg	23 kg/kkg

II. Product-Material Balance Summary

Sardine canning (Subcategory AB):
Average Production Rate = 31 kkg/day (34 tons/day)

End Products	% of Raw Product
Food products	30 - 60
By-products	
a) heads and tails (reduction or bait)	35 - 65
b) scales	1 - 2

Table 20. Sardine canning and herring filleting processes material balances (Subcategories AB, AE, AF) (continued).

Herring filleting (Subcategories AE and AF):
Average Production Rate = 78 kkg/day (86 tons/day)

End Product	% of Raw Product
Food products	42 - 45
By-product a) heads, viscera (for reduction)	55 - 58

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* Based on kkg of raw seafood

Source: US Environmental Protection Agency. 1975d. Development document for interim final effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, sardine, herring, clam, oyster, scallop and abalone segment of the canned and preserved seafood processing point source category, phase II. EPA-440/1-74-041. Washington DC.

2.1.2.13 Clam, Scallop, and Oyster Processing

Wastewaters from clam, scallop, and oyster (mollusk) processing plants are very similar. The major differences in processing occur when the oysters or clams are mechanically shucked rather than hand-shucked, because mechanical techniques require considerably more water. The main source of BOD from the clam and oyster process is the body fluids that are released from the shucking and meat washing processes. If clams or oysters are cooked before canning, additional body fluids are released. Cleansing agents for plant cleanup also add to the BOD. The suspended solids include sand washed from the mollusk meats. If the clams are minced or debellied, the washing process will add bits of meat to the wastewaters. Scallop process wastes are generally the wastes from washing the abductor muscle and preparing it for packing. The BOD is from tissue fluids, bits of meat, and plant cleaning solutions. Suspended solids are low and are mainly debris and bits of meat. Oil and grease is from the washed out tissue fluids. Table 21 shows the material balances for mechanical surf clam canning, hand-shucked clams, steamed oyster process, and hand-shucked oyster processing plants.

2.1.2.14 Abalone Processing

Wastes from abalone processing have the same characteristics as do wastes generated in processing other mollusks. The sources of BOD, TSS, and oil and grease are also the same. Table 22 shows the material balance for abalone processing.

2.1.3 Solid Waste Generation

The majority of the solid wastes from seafood processing is flumed to discharge and appears in the wastewater disposal system. In some plants these solids are dry captured or screened and sent into the solid waste system. Process solid wastes also may be sent to a fish meal plant or sent to a by-product plant for animal feed. Mollusk shells, except for the abalone which is used for decorative purposes, are generally used as construction fill material, animal food additives, or put back into the sea for substrate. The solid wastes generated by the industry have not been declared hazardous.

Table 21. Surf clam, hand-shucked clam, steamed oyster, and hand-shucked oyster processes material balances (Subcategories X,W,AA,Y, and Z).

I. Wastewater-Material Balance Summary

Surf Clam (Subcategory X)

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) iron man	1	1	1
b) first washer	35	31	52
c) first skimming table	1	1	1
d) second washer	16	24	25
e) second skimming table	15	31	15
f) washdown	33	13	8
Total effluent average*	21,000 l/kkg	13 kg/kkg	5.2 kg/kkg

Hand-shucked clam (Subcategory W):

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) first and second washers	83 - 92	65 - 97	10 - 96
b) washdown	8 - 17	3 - 34	4 - 89
Total effluent average*	5,100 l/kkg	5.3 kg/kkg	12 kg/kkg

Steamed oyster (Subcategory AA):

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) belt washer	11	10	63
b) shocker	43	9	26
c) shucker	15	11	1
d) blow tanks	7	6	1
e) washdown	23	64	10
Total effluent average**	66,500 l/kkg	30 kg/kkg	137 kg/kkg

Table 21. Surf clam, hand-shucked clam, steamed oyster, and hand-shucked oyster processes material balances (Subcategories X,W,AA,Y, and Z) (continued).

Hand-shucked oyster (Subcategories Y,Z):

East Coast

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) blow tank	71 - 94	81 - 94	11 - 58
b) washdown	6 - 29	6 - 19	42 - 89
Total effluent average**	37,000 l/kkg	14 kg/kkg	11 kg/kkg

West Coast

Unit Operation	% Flow (Avg)	% of Total BOD	% of Total Susp. Solids
a) blow tank	45 - 68	83 - 95	24 - 75
b) washdown	32 - 55	5 - 17	25 - 76
Total effluent average**	41,000 l/kkg	25 kg/kkg	26 kg/kkg

II. Product-Material Balance Summary

Surf clam (Subcategory X):
Average Production Rate = 38 kkg/day (41 tons/day)

End Products	% of Raw Product
Food products	10 - 15
By-products a) shell	75 - 80
Wastes a) belly	7 - 10

Hand-shucked clam (Subcategory W):
Average Production Rate = 20 kkg/day (22 tons/day)

Data on product material balance are not available.

Table 21. Surf clam, hand-shucked clam, steamed oyster and hand-shucked oyster processes material balances (Subcategories X,W,AA,Y, and Z) (continued).

Steamed oyster (Subcategory AA):
Average Production Rate = 6.8 kkg/day (7.5 tons/day)
(Production measured in terms of final product)

Data on product material balance are not available.

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[*] Based on kkg of raw seafood

[**] Based on kkg of product

Source: US Environmental Protection Agency. 1975d. Development document for interim final effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, sardine, herring, clam, oyster, scallop and abalone segment of the canned and preserved seafood processing point source category, phase II. EPA-440/1-74-041. Washington DC.

Table 22. Abalone fresh/frozen process material balance (Subcategory AG).

I. Wastewater-Material Balance Summary

Abalone fresh/frozen (Subcategory AG):

Unit Operation	% Flow(Avg)	% of Total BOD	% of Total Susp. Solids
a) process water	49	50	39
b) wash tank	26	20	42
c) washdown	25	30	19
Total effluent average*	47,100 l/kkg	27 kg/kkg	11 kg/kkg

II. Product-Material Balance Summary

Abalone fresh/frozen (Subcategory AG):
Average Production Rate = 0.34 kkg/day (0.38 tons/day)

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* Based on kkg of raw seafood

Source: US Environmental Protection Agency. 1975d. Development document for interim final effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, sardine, herring, clam, oyster, scallop and abalone segment of the canned and preserved seafood processing point source category, phase II. EPA-440/1-74-041. Washington DC.

Quantities of solid wastes have not been determined for all of the subcategories. Table 23 presents data on solids generated by the production of seafoods and retained on a 20 mesh screen. In some cases, the mass of screened solids exceeds the raw product input. This anomalous occurrence may be attributed to the way in which a representative sample was collected. Samples to be screened were gathered in proportion to flow and then combined with an appropriate quantity of batch and intermittent flow wastes. Since the finished product is a small percentage of the raw seafood, high values of solids generated are realized (USEPA 1974a). In addition to process scraps, solid wastes are generated from scrap packing and shipping containers. In remote areas, old machinery and scrap from can making also may be included. The material quantities vary with plant and location, but they have an impact on the local landfills

2.2 ENVIRONMENTAL IMPACTS OF INDUSTRY WASTES

2.2.1 Air Impacts

The fate of pollutants discharged into the atmosphere is a highly complex subject because of the many variables associated with such evaluations:

- Wind direction and atmospheric stability effects on the dispersion of pollutants.
- Chemical and physical reactions of emitted pollutants.
- Background pollutant contributions.
- Hypersensitive groups within the general population.

The air quality impacts from process emissions can be predicted using simple hand calculation models or highly complex computer mathematical models. The selection of the appropriate technique is dependent upon the potential significance of the air quality impacts and regulatory agency requirements (discussed in Section 1.5).

Based on the potential emissions from the seafood industry processes as discussed in Section 2.1.1, it is most probable that the typical new source seafood industry will not be considered a major point source and will not be

Table 23. Solids generation from seafood industry wastewater streams (based on retention by 20 mesh screen).

Process	Mean*	Range*
Farm raised catfish	3.2	2.5 - 3.9
Alaska crab meat, frozen or canned:		
with screening and by-product recovery	120	79 - 157
with grinding	850	520 -1,200
Alaska whole crab and sections:		
with screening and by-product recovery	22	18 - 25
with grinding	300	28 - 470
Alaska shrimp, frozen	25	14 - 43
Alaska shrimp, canned	760	200 -1,300
Tuna	1.3	0.95 - 1.7
Salmon canning:		
with screening and by-product recovery	25.4	15 - 47.7
with grinding	48.3	11.3 - 114
Fresh/frozen salmon	1.3	0.16 - 3.58
Bottom/ground fish	3.9	0.51 - 30.4
Frozen whiting	11.2	2.1 - 21.9
Croaker fish flesh	5.8	1.9 - 9.6
Frozen halibut	8.1	4.7 - 11.1
Fletched halibut	0.8	0.4 - 1.1
Sardines	0.36	0.11 - 0.8
Herring fillets	6.8	-
Surf clams	1.92	0.75 - 4.7
Hand-shucked clams	5.6	1.5 - 11.7
Mechanically shucked oysters**	200	36 - 480

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* kg/kkg of raw seafood, except for oysters (**), kg/kkg of product.

Table 23. Solids generation from seafood industry wastewater streams (based on retention by 2 mesh screen) (continued).

Sources: US Environmental Protection Agency. 1974a. Development document for proposed effluent limitations guidelines and new source performance standards for the catfish, crab, shrimp, and tuna segment of the canned and preserved seafood processing point source category. EPA-440/1-74-020. Washington DC.

US Environmental Protection Agency. 1975d. Development document for proposed effluent limitations guidelines and new source performance standards for the fish meal, salmon, bottomfish, sardine, herring, clam, oyster, scallop, and abalone segment of the canned and preserved seafood processing point source category, phase II. EPA-440/1-74-041. Washington DC.

required to undergo a full PSD review and permit application. However, this must be determined by USEPA and the state on a case-by-case basis, and the applicant must address this need in the EID. Also, the applicant must address each pollutant separately (e.g., total suspended particulates, sulfur oxides, hydrocarbons). Since a detailed review is not likely, air quality modeling requirements will be minimal. (If the applicant desires more information on accepted modeling techniques, a recommended reference is "Guidelines on Air Quality Modeling," EPA-450/2-78-027 (USEPA 1978)).

The pollutant most likely to have an effect on air quality will be organics emissions associated with the biodegradation of the raw materials, products, and waste products. These highly odorous organics will be subject to dispersion and dilution in the atmosphere, but such compounds can have extremely low threshhold limits of detection. The modeling of these organic concentrations in the environment represents research-level efforts in the air quality field.

2.2.2 Water Impacts

The pollutants generated by the seafood processing industry mainly are BOD, suspended solids, and oil and grease. The industry wastewaters also may have a pH (hydrogen ion concentration) that varies significantly from values that occur in the natural environment. These pollutants may interact with natural systems to cause a deterioration in the water quality of receiving streams:

- Biochemical oxygen demand (BOD). The organic fraction of seafood wastes can exert a large BOD on receiving waters. Since the BOD of a wastewater estimates the dissolved oxygen that will be consumed as the waste materials are degraded, this pollutant parameter represents the potential of the waste to reduce the dissolved oxygen resources of a body of water. It is possible to reach conditions which totally exhaust the dissolved oxygen in the water resulting in anaerobic conditions and the production of undesirable gases such as hydrogen sulfide and methane. The reduction of dissolved oxygen can be detrimental to fish populations, fish growth rate, and organisms used as fish food (USEPA 1976). A total lack of oxygen can result in the death of all aerobic aquatic inhabitants in the affected area. Water with a high BOD indicates the presence of decomposing organic matter and associated increased bacterial concentrations that degrade its quality and potential uses (USEPA 1976). Algal blooms can produce high BOD as a result of decaying organic matter.

- Total suspended solids (TSS). The TSS in seafood processing wastewaters will include both organic and inorganic materials. The inorganic compounds include sand and shell fragments. The organic fraction includes such materials as grease, oil, and seafood waste products (USEPA 1974a-c; 1975a-d). Some of the solids generated within a seafood processing plant are removed readily by fine screening; other solids settle readily in clarifiers. When not removed, these solids can foul or plug pipes, pumps, and other mechanical equipment. These solids may settle out rapidly and bottom deposits are often a mixture of both organic and inorganic solids. Solids may be suspended in water for a time and then settle to the bed of the receiving water. They may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension they increase the turbidity of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants (USEPA 1976). Elevated levels of suspended solids may also increase the chlorine demand required for adequate disinfection.

  Aside from any toxic effect attributable to substances leached out by water, suspended solids may kill fish and shellfish by causing abrasive injuries, by clogging gills and respiratory passages, screening out light, and by promoting and maintaining the development of noxious conditions through oxygen depletion. Suspended solids also reduce the recreational value of the water (USEPA 1976).

- Oil and Grease (O & G). Oil and grease cause troublesome taste and odor problems even in small quantities. They produce scum lines on water treatment basin walls and other containers and adversely affect fish and waterfowl. Oil emulsions may adhere to the gills of fish, causing suffocation, and may taint the flesh of fish microorganisms that were exposed to waste oil. Oil deposits in the bottom sediments of water can serve to inhibit normal benthic growth. Oil and grease also exert an oxygen demand in the natural environment (USEPA 1976).

  Oil and grease levels which are toxic to aquatic organisms vary greatly, depending on the type of pollutant and the species susceptibility. In addition, the presence of oil in water can increase the toxicity of other substances discharged into the receiving bodies of water (USEPA 1976).

- pH (hydrogen ion concentration). The pH of a wastewater stream largely is significant in that it affects corrosion control, pollution control, disinfection, and toxicity of other pollutants. Waters with a pH below 6.0 corrode waterworks structures, distribution lines, and household plumbing fixtures. This corrosion can add such constituents to drinking water as iron, copper, zinc, cadmium, and lead. Low pH waters not only tend to dissolve metals from structures and fixtures but also tend to redissolve or leach metals from sludges and bottom sediments. The hydrogen ion concentration also can affect the taste of water; at a low pH, water tastes "sour." Extremes of pH or rapid pH changes can stress or kill aquatic life. Even moderate changes from "acceptable" pH limits can harm some species. Changes in water pH increase the relative toxicity to aquatic life of materials. Metalocyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units. The toxicity of ammonia similarly is a function of pH. The bactericidal effect of chlorine in most cases lessens as the pH increases, and it is economically advantageous to keep the pH close to 7 (USEPA 1976).

The prediction of the impacts these pollutants will have on the natural environment is improved by the use of mathematical modeling of the dispersion and dissipation water pollutants. Two of the most widely used and accepted models are:

- DOSAG (and its modifications); and
- the QUAL series of models developed by the Texas Water Development Board and modified by Water Resources Engineers, Inc.

These are steady-state, one-dimensional models useful in evaluating stream impacts. Some of the parameters that these models simulate are:

- Dissolved oxygen.
- BOD.
- Temperature.
- pH.
- Solids.

The data required for these models include:

DOSAG-I

- Flow rates for system inputs and withdrawals.
- Information on reaches, junctions, stretches, headwater reaches.
- Reaction coefficients.
- Concentrations of inflows.
- Stream temperature.

QUAL-II

- Identification and description of stream reaches.

- Initial conditions.
- Hydraulic coefficients for determining velocity and depth.
- Reaction coefficients.
- Headwater data.
- Waste loadings and runoff conditions.
- If temperature is to be modeled, it also would require sky cover, wet bulb/dry bulb air temperature, atmospheric pressure, wind speed, evaporation coefficient, and basin elevation.

Other models are available for non-steady conditions and two dimensions, as required in modeling estuaries, including:

- RECEIV and RECEIV II, developed by Raytheon for the USEPA Water Planning Division.

These models can evaluate both conservative materials (e.g., dissolved solids, metals) and non-conservative materials subject to first order reaction kinetics (e.g., BOD, DO). The data required as input to both of these models include:

- Tidal variations.
- Water surface elevations, area, and depth.
- Bottom roughness coefficients.
- Meteorological data, including rainfall, evaporation, and wind velocity and direction.
- Downstream boundary conditions.
- Junction and channel data.
- Water temperature.
- Initial pollutant concentrations.
- Inflow data.
- Oxygen saturation and reaeration coefficients.

There are many other available water quality models developed for specific situations or in association with NPDES activity. The applicant should discuss in detail the assumptions used in developing the model for the proposed facility, other applications of the model that indicate it is applicable to the proposed situation, and any calibration performed to verify the reasonableness of the assumed conditions.

2.2.3 Biological Impacts

There may be direct biological effects from the wastes generated by the canned and preserved seafoods industry (e.g., accumulation of solids near a wastewater outfall that smothers bottom organisms) but there also may be important effects due to the air and water impacts described previously (e.g., decreased levels of dissolved oxygen in the natural waters).

2.2.3.1 Human Health

The discharge of wastes from seafood processing plants can have direct and indirect impacts on human health. Where old stickwater or rendered oils are discharged, there is the possibility of causing unpleasant tastes in mollusks. Also, some fin fish may feed at the outfalls and acquire an unpalatable taste from the seafood being processed. Although not a direct health effect, the seafood from these areas must be avoided by the public. Where there is an excessive coliform count in the outfall, shellfish beds may exceed the quality standards.

Vibrio parahemolyticus is a pathogen for both seafood and warm-blooded animals, and it has been implicated in unconfirmed and confirmed outbreaks of food-borne illnesses associated with consumption of seafood. It has been found in moribund crabs, diseased fish, clams, oysters, shrimp, and eels, and occurs in high densities in marine environments which contain chitinous material such as crab and shrimp shells. Where bottom sediments are highly putrescible and anaerobic, it is possible for *Clostridium botulinum* to grow and to be brought into the processing system by dirt adhering to fish or to workers' and fishermen's boots. The bacterium then may enter the processing line and, unless the fish are properly processed, it can persist in canned or smoked fishes. These bacteria generate the powerful toxin that causes botulism poisoning, which frequently results in death.

Whenever improperly cooked or dried fish are consumed, there is the possibility that the consumer will contract fish tapeworm. Gulls feeding on dead salmon or salmon cannery wastes have been implicated in the life cycle of this organism. Therefore, the discharge of solid wastes under uncontrolled conditions, either to the waterways or to land surfaces, may create health problems for surrounding residents.

2.2.3.2 Ecological Impacts

Pollution resulting from human activities is a form of environmental stress that can seriously disrupt natural communities. Many organisms cannot adjust to the changing conditions of their habitat. Natural selection and evolution have produced species that can cope with many types of naturally occurring situations, but many organisms may not be able to adjust to man-made changes to their habitat. For example, a seasonal change in water temperature may cause some organisms to become dormant or to leave the area; other organisms capable of functioning in the changed conditions may increase in abundance, if already present, or may move into the area vacated by the intolerant species. Man-made pollutional stress may change conditions so radically that no species can adapt or colonize the vacant habitat. Under such conditions, two major changes usually occur in community structure: 1) a reduction in the total number of species present; and 2) an increase in the number of individuals of those species which can survive the pollutional stress. The resulting decrease in the diversity of the community can reduce significantly the stability of the ecosystem.

Seafood processing activities can affect both terrestrial and aquatic ecosystems. Terrestrial impacts usually are limited to the construction phase and the land disposal of solid wastes. Normal processing operations generally have a minimal effect on terrestrial communities. Operational impacts on aquatic plants and animals can be significant; the following environmental components are important factors in aquatic communities and can be affected by seafood processing activities to some degree:

- Physical properties of the water. The physical properties of receiving waters are altered by the addition of large amounts of suspended solids from seafood processing activities. Gas exchange is impaired when respiratory membranes are coated with particulates, and filter-feeding organisms may be unable to adjust to the increased solids concentration. Water temperatures also may be altered. Many organisms are very sensitive to temperature changes and the effluent discharged from various processing tasks can result in fluid streams that differ significantly in temperature from that of receiving waters.

- Chemical properties of the water. One of the major impacts of processing operations and waste discharge is the change in the chemical composition of the receiving waters. The addition of large quantities of biochemical oxygen demand (BOD) can result in a significant decrease in dissolved oxygen levels. Increased amounts of anaerobic decomposition of these organic materials can produce toxic compounds, especially hydrogen sulfide. Chlorination of processing water may result in locally significant increases in receiving water concentrations of chlorine and chlorinated compounds. The elevated levels of these materials may affect local aquatic populations adversely. Water movements usually are not affected greatly by processing activities. Exceptions to this general rule may result from construction of piers, jetties, and similar structures.

- Water movements. Water movements may be altered slightly in the immediate vicinity of the effluent outfall or from the construction of piers and jetties.

- Light penetration. The addition of large amounts of suspended solids to local receiving waters can reduce light penetration. The degree of reduction depends on local currents, amounts of solids discharged, and ambient levels of suspended solids prior to the dischargers. The importance of this effect is the lessened productivity of algal populations, an important component of the aquatic food chain.

- Substratum effects. Bottom-dwelling organisms may be buried by wastes that accumulate, with a high mortality among non-mobile species. The changed benthic population can result in subsequent changes in other aquatic assemblages. Soft waste materials can accumulate over large areas, exceeding the rate that they can be decomposed, with the resulting layer of organic sludge forming a bottom habitat that few species can occupy. Harder waste materials may form large underwater mounds that support little aquatic life.

All of the factors noted above can affect the quantity and quality of food resources. Shifts in these resources caused by pollution will alter aquatic communities, but the magnitude and overall significance of such changes will vary according to the specific project. For example, seafood wastes can provide a food source for many species with a beneficial effect on their productivity. However, such an increase in productivity is similar to the problems associated with eutrophication in freshwater lakes. Thus, the alteration of community structure and stability must be evaluated on a case by case basis.

The effects of pollutional stress may be both immediate and delayed. Organisms may be killed outright by the altered conditions of their habitat. For example, fish kills can result when dissolved oxygen levels are reduced greatly or when respiration is impaired because gill membranes are clogged by sediment and suspended solids. A more subtle impact results from sub-lethal stress effects. Weakened organisms may be unable to function efficiently and may succumb to disease. Their ability to avoid predators may be reduced and reproduction may be decreased. Thus, both the acute and chronic effects of pollution act to destabilize natural communities.

2.3 OTHER IMPACTS

2.3.1 Aesthetics

The physical features of a seafood processing plant that will impact the surrounding environment are discussed in Section 1.0. Exterior design will be determined largely by the type of seafood processed and the processing equipment. Capacity will influence the overall size. New roads, unloading docks, air strips, vessel servicing facilities, and anchorages must be considered in planning for a new plant. The magnitude and significance of vehicular or vessel noises and emissions as well as other mobile emissions must be assessed in the EID. Locating a processing plant out of view of a major road is a consideration, but the EID also must consider factors such as safe access for boats, convenience to seafood sources, and water. The prevailing winds should be considered also to ensure locating a facility so that odor problems with the surrounding neighborhood are mitigated. The applicant should consider the following factors to reduce potential aesthetic impacts:

- Existing Nature of the Area. The topography and major land uses in the area of the candidate sites are important. Topographic conditions and existing trees and vegetational visual barriers can be used to screen the operation from view. A lack of topographic relief and vegetation would require other means of minimizing impact, such as regrading or the planting of vegetation buffers.

- Proximity of Parks and Other Areas Where People Congregate for Recreation and Other Activities. The location of public use areas should be mapped and presented in the EID. Representative views of the plant site from observation points should be described. The visual effects on these recreational areas should be described in the EID in order to develop the appropriate mitigative measures.

- Transportation System. The visual impact of new access roads, barge docking, and storage facilities on the landscape and waterfront should be considered. Locations, construction methods and materials, and maintenance should be specified.

2.3.2 Noise

The major sources of external noise associated with a seafood processing plant include:

- Vessel unloading.
- Power generation.
- Transportation equipment.

These may produce significant noise impacts especially during the processing season when more than one shift per day may be operating the plant. Sound measurements can be determined from the types of equipment used. The effects on the surrounding area can be evaluated using standard noise diminution tables. In addition, a survey of the effect of vegetation buffer strips in mitigating noise levels will be helpful in planning a new plant.

The means that exist to reduce noise generated by particular sources include:

- Enclosed process machines.
- Mufflers on engines.
- Sound barriers and isolation.
- Vibration insulation.

Noise levels of equipment maintained in good operating condition usually are considerably lower than if the equipment is neglected. The EID should address operation and maintenance of the plant equipment to ensure that design noise levels are maintained.

The USEPA has recommended a maximum 75 dBA, 8-hour exposure level to protect workers from loss of hearing. A maximum 55 dBA background exposure level is recommended to avoid annoyance during outdoor activity (USEPA 1974d). A suitable methodology to evaluate noise generated from a proposed new source facility would require the applicant to:

- Identify all noise-sensitive land uses and activities adjoining the proposed plant site (e.g., schools, parks, hospitals, and businesses in the urban environment; homes and wildlife sanctuaries in the rural environment).
- Measure the existing ambient noise levels of the areas adjoining the site.
- Identify existing noise sources in the general area, such as traffic, aircraft flyover, and other industry.
- Determine whether there are any state or local noise regulations that apply to the site.
- Calculate the noise level of the seafood facility processes, and compare that value with the existing area noise levels and the applicable noise regulations.
- Assess the impact of the operations's noise and, if required, determine noise abatement measures to minimize the impact (e.g., quieter equipment, noise barriers, improved maintenance schedules).

2.3.3 Energy Supply

In planning a new seafood processing plant, all sources of energy available at a given site must be considered, and their potential impact on the environment must be carefully determined. A thorough analysis of energy impacts should, at a minimum, provide the following information:

- Total external energy demand for operation of facility.
- Total energy available on site.
- Energy demands by type.
- Proposed measures to reduce energy demand and increase plant efficiency.
- Proposed energy sources and alternatives.

Cogeneration should be considered in siting and designing a seafood processing plant. For example, seafood plants usually need large quantities of hot water for cleanup. The use of waste heat from power generation or freezer plants compressors for part of this heat is possible and should be evaluated.

2.3.4 Socioeconomics

Seafood processing facilities are usually small complexes, but their construction may cause land use, economic, and social changes. Therefore, it is necessary for an applicant to evaluate the types of impacts or changes that may occur. The importance of these changes usually depends on the size of the existing community where the facility is located, with the significance of the changes normally greater near a small rural community than near a large urban area. This is due to the fact that a small rural community is more likely to have a nonmanufacturing economic base and a lower per capita income, fewer social groups, a more limited socioeconomic infrastructure, and fewer leisure pursuits than a large urban area. In addition, much of the labor force employed by a seafood plant may be seasonal and brought in from another region, which could affect small communities more significantly. There are situations, however, in which the changes in a small community may not be significant and, conversely, in which they may be considerable in an urban area. For example, a small community may have had a manufacturing (or natural resource) economic base that has declined. As a result, such a community may have a high incidence of unemployment in a skilled labor force and a surplus of housing. Conversely, a rapidly growing urban area may be severely strained to provide the labor force and services required for a new seafood processing facility.

The rate at which changes occur (regardless of the circumstances) also is often an important determinant of the significance of the changes. The applicant should distinguish clearly between those changes occasioned by the construction of the facility, and those resulting from its operation. The former changes could be substantial but usually are temporary; the latter may or may not be substantial, but normally are more permanent in nature. The potential impacts which should be evaluated include:

- Increased land consumption and rate of land development.
- Land use pattern and compatibility changes.

- Economic base multiplier effects.
- Population size and composition changes.
- Increased labor force participation and lower unemployment rates.
- Increased vehicular traffic and congestion.
- Loss of prime agricultural land and environmentally sensitive areas.
- Increased demand for community facilities and services.
- Increased demand for water supply, sewage treatment, and solid waste disposal facilities.

During the construction phase, the impact will be greater if the project requires large numbers of construction workers to be brought in from outside the community than if local unemployed workers are available. The potential impacts include:

- Creation of social tension.
- Short-term expansion of the local economy.
- Demand for increased police and fire protection, public utilities, medical facilities, recreation facilities, and other public services.
- Increased demand for housing on a short-term basis.
- Strained economic budget in the community where existing infrastructure becomes inadequate.
- Increased congestion from construction traffic.

Various methods of reducing the strain on the budget of the local community during the construction phase should be explored. For example, the company itself may build the housing and recreation facilities and provide the utility services and medical facilities for its imported construction force; or the industry may prepay taxes, and the community may agree to a corresponding reduction in the property taxes paid later. Alternatively, the community may float a bond issue, taking advantage of its tax-exempt status, and the company may agree to reimburse the community as payments of principal and interest become due.

During operation, the more extreme adverse changes of the construction phase are likely to disappear. Long-term changes may be profound, but less extreme, because they evolve over a longer period of time and may be both beneficial and adverse.

The permit applicant should document fully in the EID the range of potential impacts that are expected and demonstrate how possible adverse changes will be handled. For example, an increased tax base generally is regarded as a positive impact. The revenue from it usually is adequate to support the additional infrastructure required as the operating employees and their families move into the community. The spending and respending of the earnings of these employees has a multiplier effect on the local economy, as do the interindustry linkages created by the seafood processing facilities. The linkages may be backward (those of the facility's suppliers) or forward (those of the facility's markets).

Socially, the community may benefit as the increased tax base permits the provision of more diverse services of a higher quality, and the variety of its interests increases with growth in population. Conversely, the transformation of a small community into a larger community may be regarded as an adverse change by some of the residents who chose to live in the community, as well as by those who grew up there and stayed, because of its small town amenities.

The applicant also should consider the economic repercussions if, for example, the quality of the air and water declines as a result of wastes generated by the seafood processing facility. In some cases, traditional sectors of economic activity may decline because labor is drawn away from them into higher paying industrial jobs. Also the tourist sector may decline if air and water pollution is noticeable or if the landscape is degraded.

Thus, the applicant's framework for analyzing the socioeconomic impacts of the facility location must be comprehensive. Most of the changes described can and should be measured to assess fully the potential costs and benefits. The applicant should distinguish clearly between the short-term (construction) and long-term (operation) changes, although some changes may be common to both (e.g., the provision of infrastructure). The significance of the changes depends not only on their absolute magnitude, but on the rate at which they occur. The applicant should develop and maintain close coordination with state, regional, and local planning and zoning authorities to ensure full understanding of all existing and/or proposed land use plans and other related regulations.

USEPA's Office of Federal Activities is developing a methodology to be used to forecast the socioeconomic impacts of new source industries and the environmental residuals associated with those impacts.

2.3.5 Shipping, Storing, and Handling Raw Materials and Products

The raw materials for all subcategories of the seafoods processing industry are fresh seafoods, which are subject to rapid deterioration in quality and must be rapidly processed. The applicant should address conditions and situations that could lead to disposal requirements of the raw materials. Typical conditions that should be addressed include:

- Periodically, a larger catch is made than the processing plants can handle, especially in the salmon and herring fisheries. When this occurs, the excess fish may be dumped overboard which creates an undue stress on the aquatic environment.
- A power failure before a process is completed will make the product unacceptable. The cans of fish or partially processed fish must be disposed, possibly at a landfill.
- Most seafood processing plants use liquid chlorine or hypochlorite as the sanitizing agent. If liquid chlorine is handled improperly, the impact to human health may be immediate, as in cases of leakage or pipe rupture.

The applicant should identify other situations where materials or their disposal may impact the environment, and demonstrate that facilities are available and procedures will be followed to mitigate expected adverse impacts.

2.3.6 Special Problems in Site Preparation and Facility Construction

The environmental effects of site preparation and construction of new seafood processing plants are common to land disturbing activities on construction sites in general. Erosion and sometimes sedimentation, dust, noise, vehicular traffic and emissions, and some loss of wildlife habitat are to be expected and should be minimized through good construction practices wherever possible. At present, however, neither the quantities of the various pollutants resulting from site preparation and construction nor their effects on the integrity of aquatic and terrestrial ecosystems have been studied sufficiently to permit broad generalizations.

The applicant must consider the capacity of the soils and geology to accommodate production and waste storage. In choosing and preparing the site, special care should be taken to avoid disturbance of wetland areas. A Section 10/404 permit may be required if wetlands will be potentially impacted. Other problems which would require special consideration include:

- Unstable soils.
- Steep topography.
- Location relative to floodplains.
- Permeability of soils.
- Erosion problems during construction and operation.
- Groundwater quality (especially in areas with groundwater problems).

In addition to the impact assessment framework provided in the USEPA document, Environmental Impact Assessment Guidelines for Selected New Source Industries, the permit applicant should tailor the conservation practices to the site under consideration in order to account for and to protect site-specific features, including:

- Critical habitats.
- Archaeological/historical sites.
- High quality streams.
- Other sensitive areas on the site.

The evaluation of site limitations should not be limited to the immediate vicinity of the project but should consider areawide restrictions, such as:

- Proximity to national refuges, parks, and other pristine areas.
- Area water resource compatibility with industrial development.
- Existing hazardous solid waste disposal facilities for the area.
- Potential for developing solid waste disposal systems.
- Community attitudes and goals relative to industrial development.

These should be addressed with respect to the mitigative techniques available to the applicant. (See Section 4.0 for a detailed discussion of site selection criteria).

3.0 POLLUTION CONTROL

New sources must attain discharge levels which are indicated as achievable using technological options which meet the New Source Performance Standards (NSPS). They may be the technologies identified by USEPA in the development of these standards or they may be alternatives which meet these standards by other techniques. For waste streams not specifically addressed by NSPS, control applications which represent the state of the art should be described in the EID. The permit applicant must demonstrate that NSPS will be met. The sections which follow identify and describe typical Standards of Performance and state-of-the-art technologies with which NSPS can be met.

3.1 STANDARDS OF PERFORMANCE TECHNOLOGY: AIR EMISSIONS

Air emissions from the seafood processing industry are significant only for the fish meal subcategory, where dust will require control equipment. Other areas that should be addressed in the EID for their potential emissions are boiler emissions (where applicable) and odor generation. Available technologies include:

- Dust Control. Cyclone collectors or bag houses are available to remove dust. Wet scrubbing is another available technique, but this generates a wastewater stream for treatment and disposal.
- Boiler Equipment. Boiler flue gas may contain several air contaminants controlled by PSD and NAAQS (e.g., total suspended particulates, nitrogen oxides, sulfur dioxide). However, these are low volume sources, so that oil and gas-fired units usually require no pollution control measures to comply with guidelines. If a large coal-fired boiler were proposed, then wet scrubbers or electrostatic precipitators to remove fly ash from the stack gas might be required. These units are capable of 98+% removal of fly ash.
- Odor. Odor can be associated with the decay of putrescible waste materials. The control of these materials should be addressed in the EID. The applicant should specifically identify the control techniques proposed to minimize odor generation such as closed containers for solid waste materials or daily (or more frequent) removal of wastes.

3.2 STANDARDS OF PERFORMANCE TECHNOLOGY: WASTEWATER DISCHARGES

Seafood processing plants may elect to achieve the required pollutant reduction with well-designed and operated external treatment systems or by a combination of both internal and external controls that may prove to be more cost-effective.

3.2.1 In-Process Controls

Internal control measures are procedures to reduce pollutant discharges at their origin, some of which result in recovery of by-products and reduce energy consumption. As most seafood processing plants include similar processes (see Figure 1), the following in-plant controls are available to all subcategories and should be considered by the applicant where applicable.

- Bail water may be reduced by converting to a vacuum or dry unloading system.
- Reduction of flume water by using dry product conveyer systems (dry belts, containers, or pneumatic ducts).
- Reduction of cleanup water by using spring-loaded nozzles on all washdown hoses.
- Use of dry processing methods such as vacuum eviscerators, dry skinners, and dry filleting machines.
- Reduction of product rinse waters by use of high pressure sprays instead of overflowing wash vats.
- Screening of solids from process streams before large quantities of water are mixed into the waste stream.
- Wherever possible, using waste heat from power generation or steam boilers for heating water or drying solids.
- Designing and constructing processing plants for maximum clean-up and maintenance efficiency.

Recommendations for specific controls in each subcategory have been identified and are included in Table 24.

Table 24. In-process techniques for wastewater control applicable to subcategories of the seafoods processing industry.

Subcategory	In-process Techniques
Farm Raised Catfish	• Holding system with a partial recycle to reduce plant water use for harvested fish kept in live-holding tanks before processing. • Icing whole fish for transport to the plant and keeping them properly iced before processing to eliminate need for holding tank water.
Blue Crab	• Isolation of the cooker water for separate handling and disposal. • Optimization of water consumption during picking and product washing for mechanized plants which have significantly greater flow ratios.
Alaskan Crab	• Gross solids can be dry collected during the butchering process for subsequent disposal. • Optimization of cooling tank flow to mininize water use.
Dungeness and Tanner Crab	• Dry capture of waste solids prior to entering the waste stream. • Isolate highly contaminated cooker water for separate disposal on land. • Optimize water use for cooling and washing the final product.
Non-Breaded Shrimp	• Optimize equipment flows to accommodate varying raw materials and production levels.
Breaded Shrimp	• Optimize equipment flows for mechanized processes to reduce water use. • Contain spills of battering and breading mixtures to minimize organic loads.
Tuna	• Single pass thawing systems can be adapted to the recycle mode. • Optimize water use at the tables in the butchering area and during the rinsing of the product and belt conveyors.

Table 24. In-process techniques for wastewater control applicable to subcategories of the seafood processing industry (continued).

Subcategory	In-process Techniques
Fish Meal	• Processing facilities without solubles units can install evaporation units to handle stickwater. • Washdown water can be condensed into solubles with precautions taken to ensure quality.
Hand-butchered Salmon	• Dry collection of the larger solids removed from the fish. • Utilize an overflow basin to wash the product following butchering, with fresh water employed for make-up water to maintain sanitation standards.
Mechanized Salmon	• Isolate residues from the extraction process for separate disposal on land. • Use of high pressure/low volume nozzles and shut-off valves. • Immediate dewatering and collection of solids generated by butchering operations and at the areas of the sliming tables and can filling machines.
Alaskan Bottomfish	• Optimization of washwater use.
Non-Alaskan Bottomfish, Manual	• Optimize the product pre-rinse and fillet table flow for manual processing operations. • Use high pressure/low volume nozzles and shut-off valves at individual stations.
Non-Alaskan Bottomfish, Mechanized	• Immediately dewater and collect gross solids discharged from the butchering machines in appropriate containers.
Hand-shucked Clam	• Minimize water use for washing operations by proper controls and the attention of plant personnel.
Mechanized Clam	• Optimize flows required to operate processing equipment and wash the raw and final product.
Hand-shucked Oyster	• Decrease the overall washwater volume generated by manual shucking plants.

Table 24. In-process techniques for wastewater control applicable to subcategories of the seafood processing industry (continued).

Subcategory	In-process Techniques
Steamed and Canned Oyster	• Optimize water use associated with each unit operation.
Sardine	• Contain spills of oil or sauces added to the canned product.
	• Recycle can washwater to conserve water.
Scallop	• Consider batch washing as an alternative to continuous washing during packaging.
Herring Fillet	• Dewater larger solids rather than flume them from the machines.
	• Collect and dewater gross solids with mesh conveyors or similar means prior to fine screening the wastewater.
Abalone	• Optimize the washing operations.

Adapted from: Edward C. Jordan Co., Inc. 1979. Reassessment of effluent limitations guidelines and new source performance standards for the canned and preserved seafood processing point source category (draft final report). Portland ME, 287 p.

3.2.2 End-of-Process Controls

The external treatment technologies employed by the seafood processing industry are essentially the same across the range of subcategories. For this reason the discussion that follows assumes the controls are applicable to all subcategories except the tuna processing subcategory, which essentially uses all of the tuna as either human or animal foods. For the seafood processing industry, the physical and chemical treatment technologies available to meet the New Source Performance Standards include the following:

- Solids separation by screening. The purpose of such devices is to recover solids prior to subsequent wastewater treatment. The types of screens found to be most acceptable for the seafood industry have been found to be the tangential, cylindrical, vibratory, and centrifugal types. Other types of equipment available include inclined-trough screens, drilled plates, bar screens, microstrainers, and basket screens. Often a coarse screen will be used in front of a finer screen to improve performance. The performance of screening devices will vary depending upon the wastewater characteristics, the equipment selected, and the use of chemical additives. It is possible to reduce suspended solids levels as well as BOD and oil and grease attached or associated with the solids.

- Oil separation. Oil removal can be used prior to solids removal to facilitate the operation of that equipment. The common techniques used in the industry include in-line grease traps and gravity separators. Other techniques such as dissolved air flotation (DAF) are available for this operation.

- Solids separation by sedimentation. This technology does not have a wide application in the industry because of the relatively long detention times required to be effective. Conventional equipment includes grit chambers, clarifiers, and settling basins. Performance of these systems is dependent on good design (i.e., elimination of short circuiting and fairly constant flow rates).

- Physical-chemical treatment. Physical-chemical processes for treatment of the seafood industry wastewater are desirable because in many cases they have a smaller land requirement. Air flotation is a physical-chemical process that has been used extensively in conjunction with the food processing industry, often as a preliminary treatment step prior to biological wastewater treatment. Flotation technology is capable of removing BOD, suspended solids, and oil and grease, with chemical coagulants usually required to optimize performance. Variations of the technology include: vacuum flotation, dissolved air flotation, dispersed air flotation, and electroflotation. Other physical-chemical technologies that have been considered include reverse osmosis, acid activated clay columns, carbon adsorption, and chemical coagulation/sedimentation systems.

- High rate aerobic biological systems. The industry wastewater is highly biodegradable and is treated well by biological systems. The difficulties with such systems are due to hydraulic surges (e.g., wash down or tank dumps) and shock loadings (e.g., cleaning operations with associated viscera and blood). Flow equalization is a common approach to improve system operation. High rate systems that are available and effective include activated sludge, rotating biologic contactors, and trickling filters. Performance is dependent upon process kinetics as determined by the wastewater and selected system.

- Low rate biological systems. These systems are effective in removing organics from the wastewater stream, but they require longer detention times than high rate systems and therefore more land. These systems include aerobic lagoons (naturally aerated or mechanically aerated) and anaerobic lagoons (possibly followed by an aerobic system). These systems are reliable for treating the highly variable waste loads that are characteristic of the industry. Performance is comparable to high rate systems, but the system must be designed carefully and consider factors such as temperature.

- Land treatment. This technology is dependent on the availability of sufficient land with the proper soil conditions. This greatly limits the applicability of this process for the seafood industry. Three general approaches could be utilized: irrigation of a cover crop or vegetation, overland flow, or infiltration-percolation. Performance of these systems is dependent upon the wastewater characteristics (screening or other preliminary treatment normally is required to remove solids), the soil characteristics, and climatic factors (e.g., annual precipitation). Where these systems can be used, essentially complete removal of pollutants found in seafood industry wastewater is possible.

- Grind and discharge. Grinding and discharge is the most common end-of-process control used in Alaska (Kawabata 1980). In this technique, the seafood waste is ground to at least 1/2" diameter prior to discharge in order to increase its surface area and hence the rate of decomposition, thereby reducing the potential for buildups of large piles of solid wastes on the bottom. Grinding and discharge is required for seafood plants in all remote Alaskan locations (40 CFR 408; as revised by 44 FR 50740, August 29, 1979).

Table 25 presents technologies and their expected performance in meeting New Source Performance Standards for the seafood processing industry. [Additional information on wastewater treatment is included in the references] (USEPA 1970, 1971a, 1971b, 1974a-c, 1975a-d; Edward C. Jordan 1979).

Table 25. Expected performance for end-of-pipe treatment systems for seafood processing industry wastewaters.

Subcategory	Applicable Technology	Influent(1) BOD_5	Influent(1) TSS	Influent(1) O&G	Effluent BOD_5	Effluent TSS	Effluent O&G
Farm Raised Catfish	Aerated Lagoon	400	440	250	100	250	25
Mechanized Blue Crab	Air Flotation(2)	--	370	150	--	110	25
Northern Shrimp	Air Flotation(2)	--	800	370	--	170	40
Southern Non-Breaded Shrimp	Air Flotation(2)	--	610	140	--	150	25
Breaded Shrimp	Air Flotation(2)	--	500	20	--	150	15
Tuna	Air Flotation(2)	--	680	400	--	160	40
Mechanized Salmon	Air Flotation(2)	--	1,200	400	--	250	90
Mechanized Bottom-fish	Air Flotation(2)	--	680	210	--	150	30
Mechanized Clam	Grit Removal	--	470	50	--	330	50
	Air Flotation(3)	--	330	50	--	150	20
Steamed and Canned Oyster	Grit Removal	--	1,990	20	--	1,400	20
	Air Flotation(3)	--	1,400	20	--	200	15
Sardine(4)	Air Flotation(2)	--	5,650	1,150	--	500	200
Herring Fillet	Air Flotation(2)	--	1,060	300	--	250	90

(1) Influent concentrations were derived from baseline wasteloads developed for the respective subcategories; reported as mg/l.

(2) Pollutant reductions are based on operation as an optimized chemical system.

(3) Treatment of grit channel effluent (70% of initial TSS concentration) with an optimized chemical system.

(4) Treatment of oil skim tank effluent, can washer, and washdown flows only.

Source: Edward C. Jordan Co., Inc. 1979. Reassessment of effluent guidelines and new source performance standards for the canned and preserved seafoods processing point source category (draft final report). Portland ME, 287 p.

3.3 STATE-OF-THE-ART TECHNOLOGY: SOLID WASTES

The solids from a seafood processing plant can be a valuable resource. During the plant design, the applicant should address systems available to use the solids in a by-product.

3.3.1 Secondary Products and By-products

The conversion of solid waste materials into secondary products and by-products is common practice in the industry at the larger and newer facilities. The detriments to these systems are the seasonal nature of many industry segments and the capital investment associated with such facilities. The recovery of solid waste materials can be characterized by the major classifications of finfish wastes (fish parts) and shellfish wastes (shells and shellfish wastes).

The recovery of finfish solid wastes can include any or several of the following (Edward C. Jordon Co., Inc. 1979):

- Secondary products. These refer to products recovered for human consumption. The best example of this technology would be the recovery of salmon roe for export to the Japanese market. This requires an investment to modify conventional processing equipment. Another potential is for the recovery, deboning, and marketing of discarded fish parts. This is practiced to a limited extent in the salmon processing segment.
- Animal food by-products. The collection of tuna wastes for use in petfood manufacture is well established. The use of finfish wastes in petfood manufacture generally is associated with the production of seafood containing other primary ingredients (e.g., beef and chicken parts).
- Bait by-products. Heads and tails can be used as bait in crab traps or for lobster fishing.
- Fish meal and oil. Conventional reduction facilities can be used to generate oil and meal from fish parts.
- Fish silage. Recent investigations indicate fish silage can be readily manufactured even at small facilities. This can be fed to pigs, cattle, or chickens.

The recovery of shellfish solid wastes includes both the biodegradable waste products and the shell wastes. The demonstrated and potential technologies available for finfish wastes are applicable to biodegradable solid waste products from the shellfish industry. Technologies available for the shell wastes include:

- Chitin separation. This technology involves a caustic extraction to remove proteins from the shell followed by demineralization with hydrochloric acid. The products from this two-stage extraction are proteins and the polysaccaride chitin, with calcium chloride brine a by-product.
- Chitosan production. Chitin is subjected to deacetylization using hot caustic to produce chitosan. Sodium acetate is recovered as a by-product. This process may be operated separately or in conjunction with the chitin separation process.

The end-users of the recovered chitosan may include the papermaking, pharmaceutical, and agricultural industries. Chitosan also may be used as a filter aid in dewatering sludge.

3.3.2 Sludge Handling

Solid waste is generated during the treatment of wastewater streams. These solids can be handled by the following operations singly or in combination:

- Thickening. This operation increases the solids concentration of a sludge, thereby reducing the volume requiring further treatment. Equipment includes gravity thickeners and dissolved air flotation units.
- Stabilization. This operation reduces the putrescible and pathogenic characteristics associated with the sludge. Aerobic and anaerobic biological systems are available.
- Conditioning. This operation normally is selected to improve the economics of subsequent operations. Alternative technologies include heat treatment and chemical additions.
- Dewatering. This removal of water from the sludge reduces the weight of the sludge and improves its handling characteristics. The technology used in the seafood industry includes centrifugation, with other industries and municipalities often using vacuum filtration, sludge drying beds, and pressure filtration.

- Drying. This operation completes the removal of water from sludges. At high temperatures (e.g., incinerators) the residual from drying may be an inert material, while at lower temperatures the residual may be useful as a soil conditioner.

- Disposal/utilization. Sludge treatment residuals will require disposal, but also may have value (e.g., as a soil conditioner).

3.3.3 Disposal Alternatives

Land disposal of sludges will be governed by regulations developed under the Resource Conservation and Recovery Act (P.L. 94-580). The potential land disposal of the industry solid wastes includes the following waste streams:

- Screened solids. These generally have a relatively low water content making disposal by conventional sub-surface techniques infeasible. Land spreading followed by immediate tilling is a potential technology that avoids the nuisance problem of odor and disease vectors such as flies.

- Dissolved air flotation sludge. The considerations for this stream include aluminum concentrations (when alum or sodium aluminate is the coagulant), as well as the sodium and salt content of the material. The general characteristics of the sludge are important as they reflect the handling difficulties during disposal.

- Waste activated sludge. These sludge characteristics are similar to those for other food processing industries, where land disposal is widely practiced. Nuisance conditions associated with odors and flies are prime considerations, with toxicity due to aluminum, sodium, and salt also an important consideration.

Landfilling of solid wastes is the most common technology, and traditionally has been the least expensive. The seafood processor may participate in the joint use of an existing sludge landfill or arrange for the co-disposal of residual solids at a conventional refuse landfill. If it is necessary to develop a landfill for the new source industry, the major factors that should be addressed include:

- Sludge characteristics (physical, chemical, and biological).
- Acceptable landfill sites available.
- Local climatological and hydrogeologic conditions.
- Regulatory requirements.

Odors and insects can be a problem with landfills, but proper design and operation should prevent such conditions.

Special solid waste disposal problems are related to the seafood industry in Alaska because of the large percentage of floaters and the more extensive use of grinding and discharge in remote areas (Kawabata 1980). Special studies concerning solid waste disposal are discussed in Section 1.3.3.

3.4 STATE-OF-THE-ART TECHNOLOGY: CONSTRUCTION POLLUTION CONTROL

The applicant also should consider the impact of construction debris on the solid waste disposal problem. The major pollutant at a construction site is loosened soil that finds its way into the adjacent waterbodies and becomes sediment. This potential problem of erosion and sedimentation is not unique to seafood processing plant construction, but applies widely to all major land disturbing activities. The applicant should demonstrate proper planning at all stages of development and application of modern control technology to minimize the production of high loads of sediment. Specific control measures include:

- Paved channels or pipelines to prevent surface erosion.
- Staging or phasing of clearing, grubbing, and excavation activities to avoid high rainfall periods.
- Storage ponds to serve as sediment traps, where the overflow may be carefully controlled.
- Mulching or seeding immediately following disturbance.

If the applicant chooses to establish temporary or permanent ground cover, grasses normally are more valuable than shrubs or trees because of their extensive root systems that entrap soil. Grasses may be seeded by sodding, plugging, or sprigging. During early growth, grasses should be supplemented with mulches of wood chips, straw, and jute mats. Wood fiber mulch also has been used as an anti-erosion technique. The mulch, prepared commercially from waste wood products, is applied with water in a hydroseeder.

4.0 EVALUATION OF AVAILABLE ALTERNATIVES

The alternatives section of the EID should address each reasonable alternative available for the new source seafood processing facility. The purpose of this analysis is to identify and evaluate alternate plans and actions that may accomplish the desired goals of the project. These alternatives can include process modifications, site relocations, project phasing, or project cancellation.

For the alternatives to a proposed project to be identified and evaluated properly, the impact assessment process should commence early in the planning phase. In this manner, social, economic, and environmental factors against which each alternative is to be judged can be established. Cost/benefit analysis should not be the only means whereby alternatives are compared. The environmental and social benefits of each alternative also must be considered. In general, the complexity of the alternative analyses should be a function of the magnitude and significance of the expected impacts of the proposed processing operations. A small processing facility located in an area with an established seafood industry may have a relatively minimal impact on a region and generally would require fewer alternatives to be presented in the EID.

The public's attitude toward the proposed operation and its alternatives also should be evaluated carefully. In this way key factors such as aesthetics, community values, and land use can be assessed properly.

4.1 SITE ALTERNATIVES

As with all industries, the seafood processing industry locates plants on the basis of several factors:

- Market demand for specific seafood products.
- Convenience to raw materials.
- Availability of an adequate labor force and water supply.
- Proximity to energy supplies and transportation.

- Minimization of environmental problems.

A variety of sites initially should be considered by the applicant. The EID should contain an analysis of each one, with the preferred alternative selected on the basis of satisfying the project objectives with the least adverse environmental impact.

Consultation with the appropriate resource agencies during the early stages of site selection is recommended. Key agencies that can provide valuable technical assistance include:

- State, Regional, County, or Local Zoning or Planning Commission. These sources can describe land use programs and determine if variances would be required. Federal lands are under the authority of the appropriate Federal land management agency (Bureau of Reclamation, US Forest Service, National Park Service, etc.).
- State or Regional Water Resource Agencies. These sources can provide information relative to water appropriations and water rights.
- Air Pollution Control Agencies. These sources can provide assistance relative to air quality allotments and other air-related standards and regulations.
- The Soil Conservation Service and State Geological Surveys. These sources can provide data and consultation on soil conditions and geologic characteristics.

Further consideration should be given to any state siting laws. The applicable regulations should be cited and any applicable constraints described.

The EID should include the potential site locations on maps, charts, or diagrams that show the relevant site information. (A consistent identification system for the alternative sites should be established and retained on all graphic and text material.) They should display pertinent information that includes, but is not limited to:

- Areas and sites considered by the applicant.
- Major centers of population density (urban, high, medium, low density, or similar scale).
- Waterbodies suitable for cooling water or effluent disposal.

- Railways, highways (existing and planned), and waterways suitable for the transportation of materials.
- Important topographic features (such as mountains).
- Dedicated land use areas (e.g., parks, historic sites, wilderness areas, testing grounds, airports).
- Other sensitive environmental areas (e.g., marshes, spawning grounds).

Using the foregoing graphic materials, the applicant should provide a condensed description of the major considerations that led to the selection of the final candidate areas, including:

- Proximity to markets and raw materials.
- Economic analyses with trade-offs.
- Adequacy of transportation systems.
- Environmental aspects, including the likelihood of floods.
- License or permit problems.
- Compatibility with existing land use planning programs.
- Current attitudes of interested citizens.
- Choice of floating processing plants versus land based plants.

The EID should indicate the steps, factors, and criteria used to select the proposed site. Quantification, although desirable, may not be possible for all factors because of lack of adequate data. Under such circumstances, qualitative and general comparative statements, supported by documentation, may be used. Where possible, experience derived from operation of other plants at the same site or at an environmentally similar site may be helpful in appraising the nature of expected environmental impacts.

The factors considered in selecting each site, and especially those that influenced a positive or negative decision on its suitability, should be carefully documented in the permit applicant's EID. Adequate information on the feasible alternatives to the proposed site is a necessary consideration in issuing, conditioning, or denying an NPDES permit. Specifically, the advantages and disadvantages of each alternative site must be catalogued with due regard to preserving natural features such as wetlands and other sensitive ecosystems and to minimizing significant adverse environmental impacts. The applicant should ascertain that all impacts are evaluated as to their significance, magnitude, frequency of occurrence, cumulative effects, reversibility, secondary or induced effects, and duration. Accidents or spills of hazardous or toxic substances vis-a-vis site location should be addressed.

A proposed site may be controversial for a number of reasons:

- Impact on a unique, recreational, archaeological, or other important natural or man-made resource area.
- Destruction of the rural or pristine character of an area.
- Conflict with the planned development for the area.
- Opposition by citizen groups.
- Unfavorable meteorological and climatological characteristics.
- Periodic flooding, hurricanes, earthquakes, or other natural disasters.

If the proposed site location proves undesirable, then alternative sites from among those originally considered would be reevaluated, or new sites should be identified and evaluated. Expansion at an existing site also could be a possible alternative solution. Therefore, it is critical that a permit applicant systematically identify and assess all feasible alternative site locations as early in the planning process as possible.

4.2 ALTERNATIVE PROCESSES AND DESIGNS

Typically, when the decision is made to expand processing capacity--either through a new plant or an addition to an existing one--the type of facility to be constructed is already fixed. If the existing plant is to be expanded, the expanded plant would not constitute a new source unless the plant were completely rebuilt (40 CFR 122.66). However, any alteration which significantly affects wastewater discharges at an existing source must be reported to USEPA in advance (40 CFR 122.66). Where the modification would change the volume or type of pollutants discharged, the existing permit would have to be changed.

In considering alternative processes and designs, the applicant should evaluate all alternatives in a systematic fashion to ensure that the most economical and environmentally sound system is used. One alternative in the design of a plant could be to design multiple use lines. In general, a seafood processing plant is not operated year-round and some salmon freezing or canning plants are in operation for only two months per year. Modifying these facilities to handle other products such as shrimp, crab, or clams could be considered by the applicant. The EID should indicate the methodology used to identify, evaluate, and select the preferred process alternative.

4.2.1 Process Alternatives

Process alternatives are usually selected on the basis of the following:

- Product demand.
- Reliability of the process.
- Economics.
- Availability of required raw materials.
- Environmental considerations.

Those alternatives that appear practical should be considered further on the basis of criteria such as:

- Land requirements of the processing facility, fuel storage facilities, waste storage facilities, and exclusion areas.
- Release to air of dust, sulfur dioxide, nitrogen oxides, and other potential pollutants, subject to Federal, state, or local limitations.
- Releases to water of heat and chemicals subject to Federal, state, and local regulations.
- Water consumption rate.
- Fuel consumption.
- Social impacts of increased traffic as materials are transported to the site and wastes are transported from the site.
- Social effects resulting from the influx of construction, operation, and maintenance crews.

- Economics.
- Aesthetic considerations for each alternative process.
- Reliability and energy efficiency.

A tabular or matrix form of display often is helpful in comparing the feasible alternatives. The EID should present clearly and systematically the methodology used to identify, evaluate, and select the preferred process alternative. Alternative processes which are not feasible should be dismissed with an objective explanation of the reasons for rejection.

4.2.2 Design Alternatives

In order to properly present alternative facility designs available for the project in the EID, the combination of component systems available for selection should be analyzed and described for the following factors:

- Capital and operating costs.
- Environmental considerations.
- System reliability and safety.

All of these factors should be documented and quantified wherever possible.

4.3 NO-BUILD ALTERNATIVE

In all proposals for industrial development, the alternative of not constructing the proposed new source facility must be considered. This analysis is not unique to the development of seafood processing facilities (see Chapter IV, Alternatives to the Proposed New Source, in the USEPA document, Environmental Impact Assessment Guidelines for Selected New Sources Industries, October 1975). The key aspects of the no-build alternative should be identified to include:

- Market Effect. Not constructing the facility may result in product shortages.
- Industry Effect. Not constructing the facility may cause dated facilities to be renovated.

- Technology Effect. Not constructing the facility may delay the need for expanded capacity, which may allow time for improved technology to be incorporated into the facility.
- Environmental Effect. Not building the facility might avoid adverse environmental effects at the proposed site, but subsequently may cause similar effects at a more sensitive site.

Other factors should be considered (e.g., specific environmental issues) as appropriate for the situation leading to the proposed action.

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6.0 GLOSSARY OF TERMS

activated sludge process: Removes organic matter from wastewater by introducing air (oxygen) into a vessel containing biologically active microorganisms.

aeration tank: A chamber for injecting air or oxygen into water.

aerobic organism: An organism that thrives in the presence of oxygen.

algae (alga): Simple plants, many microscopic, containing chlorophyll. Most algae are aquatic and may become a nuisance when conditions are suitable for prolific growth.

ammonia stripping: Ammonia removal from a liquid, usually by intimate contact with an ammonia-free gas, such as air.

anaerobic: Living or active in the absence of free oxygen.

anionic: Characterized by an active and especially surface-active anion, or negatively changed ion.

aquaculture: The cultivation and harvesting of aquatic plants and animals.

average: An arithmetic mean obtained by adding quantities and dividing the sum by the number of quantities.

bacteria: The smallest living organisms which comprise, along with fungi, the decomposer category of the food chain.

bailwater: Water used to facilitate unloading of fish from fishing vessel holds.

batter: A flowing mixture of flour, milk, cooking oil, eggs, etc. for product coating.

biochemical oxygen demand (BOD): Amount of oxygen necessary in the water for bacteria to consume the organic sewage. It is used as a measure in telling how well a sewage treatment plant is working.

biological oxidation: The process whereby, through the activity of living organisms in an aerobic environment, organic matter is converted to more biologically stable matter.

biological stabilization: Reduction in the net energy level or organic matter as a result of the metabolic activity of organisms, so that further biodegradation is very slow.

biological treatment: Organic waste treatment in which bacteria and/or biochemical action are intensified under controlled conditions.

biomass: Mass or body of activated sludge microorganisms involved in the decomposition of wastes.

blow tank: Water-filled tank used to wash oyster or clam meats by agitating with air injected at the bottom.

BOD_5: A measure of the oxygen consumption by aerobic organisms over a 5-day test period at 20°C. It is an indirect measure of the concentration of biologically degradable material present in organic wastes contained in a waste stream.

brailing: Transfer of seafood from vessel to processing plant in "brail" baskets.

breading: A finely ground mixture containing cereal products, flavorings and other ingredients, that is applied to a product that has been moistened, usually with batter.

brine: Concentrated salt solution which is used to cool or freeze fish.

BTU: British thermal unit, the quantity of heat required to raise one pound of water 1°F.

bulking sludge: Activated sludge that settles poorly because of low density floc.

by-products: (As used in this report). Commodities which are produced as a secondary or incidental product of fish processing, but which are not suitable for human consumption (e.g., petfood, fish meal, fertilizer, etc.).

canned fishery product: Fish, shellfish, or other aquatic animals packed singly or in combination with other items in hermetically sealed, heat sterilized cans, jars, or other suitable containers. Most, but not all canned fishery products can be stored at room temperature for an indefinite period of time without spoiling.

carbon adsorption: The separation of small waste particles and molecular species, including color and odor contaminants, by attachment to the surface and open pore structure or carbon granules or powder. The carbon is "activated," or made more adsorbent by treatment and processing.

catalyst: A chemical element or compound which, although not directly involved in a chemical reaction, speeds up that reaction.

cation: Characterized by an active and especially surface-active cation, or positively changed ion.

cellulose: A polysaccharide, or complex carbohydrate, found in plant cell walls and naturally occurring in such fibrous products as cotton and kapok; used as raw material in many manufactured goods including paper.

centrifuge: A mechanical device which subjects material to a centrifugal force to achieve phase separation and then discharges the separated components.

chemical oxygen demand (COD): A measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water.

chemical precipitation: A waste treatment process whereby substances dissolved in the wastewater stream are rendered insoluble and form a solid phase that settles out or can be removed by flotation techniques.

chitin: An abundant natural polysaccharide found in the shells of crustaceans, and in insect exoskeletons, fungi and certain other plants and animals.

chitosan: A deacetylized form of chitin, manufactured from chitin, and used in a variety of applications ranging from coagulation and ion-exchange wastewater treatments to adhesives and wound-healing sutures.

clarification: Process of removing undissolved materials from a liquid. Specifically, removal of solids either by settling, flotation, or filtration.

clarifier: A settling basin for separating settleable solids from wastewater.

coagulant: A material which, when added to liquid wastes or water, creates a reaction which forms insoluble floc particles that adsorb and precipitate colloidal and suspended solids. The floc particles can be removed by sedimentation. Among the most common chemical coagulants used in sewage treatment are ferric chloride, alum and lime.

coagulation: The clumping together of solids to make them settle out of the wastewater faster. Coagulation of solids is brought about with the use of certain chemicals such as lime, alum, or polyelectrolytes.

comminutor (grinder): A device for the catching and shredding of heavy solid matter in the primary stage of waste treatment.

concentration: The total mass (usually in micrograms) of the suspended particles contained in a unit volume (usually one cubic meter) at a given temperature and pressure; sometimes, the concentration may be expressed in terms of total number of particles in a unit volume (e.g., parts per million); concentration may also be called the "loading" or the "level" of a substance; concentration may also pertain to the strength of a solution.

condensate: Liquid residue resulting from the cooling of a gaseous vapor.

contamination: A general term signifying the introduction into water of microorganisms, chemical, organic, or inorganic wastes, or sewage, which renders the water unfit for its intended use.

crustacea: Mostly aquatic animals with rigid outer coverings, jointed appendages, and gills. Examples are crayfish, crabs, barnacles, shrimp, water fleas, and sow bugs.

cyclone: A device used to separate dust or mist from a gas stream by centrifugal force.

DAF sludge: Also called float; the semi-liquid skimmings, containing solids, grease, oil and other contaminants, collected from the surface of a dissolved air flotation unit.

decomposition: Reduction of the net energy level and change in chemical composition or organic matter because of actions of aerobic or anaerobic microorganisms.

denitrification: The process involving the facultative conversion by anaerobic bacteria of nitrates into nitrogen and nitrogen oxides.

deviation, standard normal: A measure of dispersion of values about a mean value; the square root of the average of the squares of the individual deviations from the mean.

digestion: Though "aerobic" digestion is used the term digestion commonly refers to the anaerobic breakdown of organic matter in water solution or suspension into simpler or more biologically stable compounds or both. Organic matter may be decomposed to soluble organic acids or alcohols, and subsequently converted to such gases as methane and carbon dioxide. Complete destruction of organic solid materials by bacterial action alone is never accomplished.

dissolved air flotation (DAF): A process involving the compression of air and liquid, mixing to super-saturation, and releasing the pressure to generate large numbers of minute air bubbles. As the bubbles rise to the surface of the water, they carry with them small particles that they contact.

dry capture: A method of disposal whereby seafood wastes are transferred by a permeable conveyor belt which allows water to separate from the seafood. This method is advantageous in that it avoids the need to flush wastes down a channel, which uses large volumes of water and increases the levels of pollutants in the discharge.

effluent: Something that flows out, such as a liquid discharged as a waste; for example, the liquid that comes out of a treatment plant after completion of the treatment process.

electrodialysis: A process by which electricity attracts or draws the mineral salts through a selective semi-permeable membrane.

end-of-pipe treatment: Treatment of wastewater after it has entered a sewer system and is no longer subject to recycle within a production process.

enzymatic digestion: Decomposition process which is assisted by the presence of naturally occurring organic catalysts called enzymes.

eviscerate: To remove the viscera, or entrails, from the body cavity.

extruded: Shaped by passing through a die or mold such as fish sticks made from deboned fish flesh.

facultative aerobe: An organism that although fundamentally an anaerobe can grow in the presence of free oxygen.

facultative anaerobe: An organism that although fundamentally an aerobe can grow in the absence of free oxygen.

facultative decomposition: Decomposition of organic matter by facultative microorganisms.

fish fillets: The sides of fish that are either skinned or have the skin on, cut lengthwise from the backbone. Most types of fillets are boneless or virtually boneless; some may be specified as "boneless fillets."

fish meal: A ground, dried product made from fish or shellfish or parts thereof, generally produced by cooking raw fish or shellfish with steam and pressing the material to obtain the solids which are then derived.

fish oil: An oil processed from the body (body oil) or liver (liver oil) of fish. Most fish oils are a by-product of the production of fish meal.

fish silage: Proteinaceous by-product resulting from the enzymatic digestion of fish wastes.

fish solubles: A product extracted from the residual press liquor (called "stickwater") after the solids are removed for drying (fish meal) and the oil extracted by centrifuging. This residue is generally condensed to 50 percent solids and marketed as "condensed fish solubles."

filtration: The process of passing a liquid through a porous medium for the removal of suspended material by a physical straining action.

float: (Also called floating sludge) Solid material resulting from dissolved air flotation treatment which remains on the surface of a liquid or is suspended near the surface.

floc: Something occurring in indefinite masses or aggregates. A clump of solids formed in sewage when certain chemicals are added.

flocculation: The process by which certain chemicals form clumps of solids in wastewater.

floc skimmings: The flocculent mass formed on a quiescent liquid surface and removed for use, treatment, or disposal.

flume: An artificial channel for conveyance of a stream of water.

freezing in the round: Freezing of the entire fish without evisceration.

glazing: A method of preserving moisture level in fish during storage by dipping fish in water and quickly freezing.

grease traps: A hydraulic device which removes grease from a waste stream.

grit chamber: A hydraulic device which removes sand, grit and other large, heavy particles from a waste stream.

groundwater: The supply of freshwater under the earth's surface in an aquifier or soil that forms the natural reservoir for man's use.

incineration: (As used in this report) The process of burning sludge to reduce the volume of material to an inert ash residue.

influent: A liquid which flows into a containing space or process unit.

in-plant controls: Technologies or management strategies which reduce the strength or volume of wastes discharged to end-of-pipe treatment systems.

ion: A free electron or other charged subatomic particle.

ion exchange: A reversible chemical reaction between a solid and a liquid by means of which ions may be interchanged between the two. It is in common use in water softening and water deionizing.

isoelectric point: Point at which the net electrical charge of particles is zero, thus causing destabilization which facilitates processes such as coagulation and flocculation.

kg: Kilogram or 1,000 grams, metric unit of weight.

kkg: Kilo-kilogram or 1,000,000 grams, metric unit of weight.

KWH: Kilowatt-hours, a measure of total electrical energy consumption.

lagoons: Scientifically constructed ponds in which sunlight, algae, and oxygen interact to restore water to a quality equal to effluent from a secondary treatment plant.

land disposal: (Also called land treatment) Disposal of wastewater into land with cropraising being incidental; the primary purpose is to cause further degradation by assimilation of organics and/or nutrients into the soil structure or the plants covering the disposal site.

landings, commercial: Quantities of fish, shellfish, and other aquatic plants and animals brought ashore and sold. Landings of fish may be in terms of round (live) weight or dressed weight. Landings of crustaceans are generally on a live weight basis except for shrimp which may be on a heads-on or heads-off basis. Mollusks are generally landed with the shell on but in some cases only the meats are landed (such as scallops).

live tank: Metal, wood, or plastic vessel with circulating seawater for the purpose of keeping fish or shellfish alive until processed.

m: Meter, metric unit of length.

mm: Millimeter, equals 0.001 meter.

mg/l: Milligrams per liter; approximately equals parts per million; a term used to indicate concentration of materials in water.

mgd: Million gallons per day.

microstrainer/microscreen: A mechanical filter consisting of a cylindrical surface of metal filter fabric with openings of 20-60 micrometers in size.

milt: Reproductive organ (testes) of male fish.

municipal treatment: A city or community-owned waste treatment plant for municipal and, possibly, industrial waste treatment.

nitrate, nitrite: Chemical compounds that include the NO_3^- (nitrate) and NO_2^- (nitrite) ions. They are composed of nitrogen and oxygen, are nutrients for growth of algae and other plant life, and contribute to eutrophication.

nitrification: The process of oxidizing ammonia by bacteria into nitrites and nitrates.

offal: A term for the waste portion of a fish, including head, tail, viscera, etc.

organic content: Synonymous with volatile solids except for small traces of some inorganic materials such as calcium carbonate which will lose weight at temperatures used in determining volatile solids.

organic matter: The waste from homes or industry of plant or animal origin.

oxidation pond: A man-made lake or body of water in which wastes are consumed by bacteria. It is used most frequently with other waste treatment processes. An oxidation pond is basically the same as a wastewater lagoon.

pH: The pH value indicates the relative intensity of acidity or alkalinity of water, with the neutral point at 7.0. Values lower than 7.0 indicate the presence of acids; above 7.0 the presence of alkalis.

physical-chemical treatment: A wastewater treatment process which relies on physical and chemical reactions, such as coagulation, settling, filtration, and other non-biological processes, to remove pollutants.

polishing: Final treatment stage before discharge of effluent to a water course, carried out in a shallow, aerobic lagoon or pond, mainly to remove fine suspended solids that settle very slowly. Some aerobic microbiological activity also occurs.

ponding: A waste treatment technique involving the actual holdup of all wastewaters in a confined space with evaporation and percolation the primary mechanisms operating to dispose of the water.

ppm: Parts per million, also referred to as milligrams per liter (mg/l). This is a unit for expressing the concentration of any substance by weight, usually as grams of substance per million grams of solution. Since a liter of water weighs one kilogram at a specific gravity of 1.0, one part per million is equivalent to one milligram per liter.

press cake: In the wet reduction process for industrial fishes, the solid fraction which results when cooked fish (and fish wastes) are passed through the screw presses.

press liquor: Stickwater resulting from the pressing of fish solids.

primary treatment: Removes the material that floats or will settle in wastewater. It is accomplished by using screens to catch the floating objects and tanks for the heavy matter to settle in.

process water: All water that comes into direct contact with the raw materials, intermediate products, final products, by-products, or contaminated waters and air.

processed fishery product: Plants and animals, and products thereof, preserved by canning, freezing, cooking, dehydrating, drying, fermenting, pasteurizing, adding salt or other chemical substances, and other commercial processes. Also, changing the form of fish, shellfish or other aquatic plants and animals from their original state into a form in which they are not readily identifiable, such as fillets, steaks, or shrimp logs.

pyrolysis: Physical and chemical decomposition of organic matter brought about by heat in the absence of oxygen.

receiving waters: Rivers, lakes, oceans, or other water courses that receive treated or untreated wastewaters.

recycle: The return of a quantity of effluent from a specific unit or process to the feed stream of that same unit. This would also apply to return of treated plant wastewater for several plant uses.

rendering: A reduction process involving the cooking, pressing, and drying o animal waste materials to produce a dry protein meal.

retort: Sterilization of a food product at greater than 248°F with steam under pressure.

reuse: Water reuse, the subsequent use of water following an earlier use without restoring it to the original quality.

reverse osmosis: The physical separation of substances from a water stream by reversal of the normal osmotic process, i.e., high pressure, forcing water through a semi-permeable membrane to the pure water side leaving behind more concentrated waste streams.

roe: Fish eggs, especially when still massed in the ovarian membrane, taken and packaged as a delicacy for human consumption.

roe stripping: Removal of reproductive tissue from fish or shellfish prior to processing.

rotating biological contactor(RBC): A waste treatment device involving closely spaced light-weight disks which are rotated through the wastewater allowing aerobic microflora to accumulate on each disk and thereby achieving a reduction in the waste content.

rotary screen: A revolving cylindrical screen for the separation of solids from a waste stream.

sand filter: Removes the organic wastes from sewage. The wastewater is trickled over a bed of sand. Air and bacteria decompose the wastes filtering through the sand and clean water flows out through drains in the bottom of the bed. The sludge accumulating at the surface must be removed from the bed periodically.

sanitary landfill: A site for solid waste disposal using techniques which prevent sector breeching, and controls air pollution nuisances, fire hazards and surface or groundwater pollution.

screen: (As used in this report) A device with openings, generally of uniform size, used to retain or remove suspended or floating solids in flowing water or wastewater and to prevent them from entering an intake or passing a given point in a conduit. The screening element may consist of parallel bars, rods, wires, grating, wire mesh, or perforated plate, and the openings may be of any shape, although they are usually circular or rectangular.

seafood: (as defined in 40 CFR 408.11c for purposes of establishing wastewater discharge criteria) the raw material including freshwater and saltwater fish and shellfish, to be processed, in the form in which it is received at the processing plant.

secondary products: (As used in this report) Fish processing products which, although not the primary product, are still suitable for human consumption (e.g., fish sticks).

secondary treatment: The second step in most waste treatment systems in which bacteria consume the organic parts of the wastes. It is accomplished by bringing the sewage and bacteria together in trickling filters or in the activated sludge process.

sedimentation tanks: Help remove solids from wastewater. The wastewater is pumped to the tanks where the solids settle to the bottom or float on top as scum. The scum is skimmed off the top, and solids on the bottom are pumped out for subsequent processing or disposal.

settleable matter (solids): Determined in the Imhoff cone test and will show the quantitative settling characteristics of the waste sample.

settling tank: Synonymous with "sedimentation tank".

sewers: A system of pipes that collect and deliver wastewater to treatment plants or receiving streams.

shock load: A quantity of wastewater or pollutant that greatly exceeds the normal discharged into a treatment system, usually occurring over a limited period of time.

shuck: A process used to remove the shells from oysters and clams.

sludge: The solid matter that settles to the bottom of sedimentation tanks and must be handled by digestion or other methods to complete the waste treatment process.

sludge dewatering: The process of removing a portion of the water in sludge by any method such as draining, evaporation, pressing, vacuum filtration, centrifuging, exhausting, passing between rollers, acid flotation, or dissolved-air flotation with or without heat. It involves reducing from a liquid to a spadable condition rather than merely changing the density of the liquid (concentration) or drying (as in a kiln).

solubles: The material which results after processing that was dissolved or able to pass into solution in the stickwater. This residue can be incorporated into fish meal or sold separately as a by-product.

species (both singular and plural): A natural population or group of populations that transmit specific characteristics from parent to offspring. They are reproductively isolated from other populations with which they might breed. Populations usually exhibit a loss of fertility when hybridizing.

stickwater: Water and entrained organics that originate from the draining or pressing of steam cooked fish products.

sump: A depression or tank that serves as a drain or receptacle for liquids for salvage or disposal.

tertiary waste treatment: Waste treatment systems used to treat secondary treatment effluent and typically using physical-chemical technologies to effect waste reduction of specific pollutants. Synonymous with "Advanced Waste Treatment."

thaw water: Water which is used to thaw frozen fish; thaw water can be heated and recycled to help conserve water within a seafood processing plant.

total dissolved solids (TDS): The solids content of wastewater that is soluble and is measured as total solids content minus total suspended solids.

total suspended solids (TSS): The wastes that will not sink or settle in municipal and industrial wastewaters.

trickling filter: A bed of rocks, stones or plastic media. The wastewater is trickled over the bed so the bacteria can break down the organic wastes. The bacteria accumulate on the media through repeated applications of wastewater.

vacuum unloading: A method of removing fish from a vessel by use of a large vacuum device.

viscera: (Singular viscus) The internal organs of a body, especially those of the abdominal and thoracic cavities.

waste: Material that is superfluous or rejected; something that can no longer be used for its originally intended purpose.